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A Citizen-Centred Approach to Education in the Smart City: Incidental Language Learning for Supporting the Inclusion of Recent Migrants

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ABSTRACT

Smart cities are often developed in a top-down approach and designers may see citizens as bits within data flows. A more human-centred perspective would be to consider what the smart city might afford its citizens. A high speed, pervasive network infrastructure offers the opportunity for ubiquitous mobile learning to become a reality. The MASELTOV project sees the smart city as enabling technology enhanced incidental learning: unplanned or unintentional learning that takes place in everyday life, in any place, at any time, with the city itself the context and the prompt for learning episodes. Migrants in particular will benefit: limited in their opportunity to attend formal education yet with a pressing need for language learning to support their integration. Incidental learning services, like smart city planning, need interdisciplinary communication for successful development. The authors describe the MASELTOV Incidental Learning Framework which will act as a boundary object to facilitate this process.

Keywords: Boundary Object, Incidental Learning, Informal Learning, Learning Frameworks, Migrants, Mobile Learning, Situated Learning

INTRODUCTION

Smart cities, with their highly developed networked infrastructures, offer technological “affordances” (Gibson, 1979). However, the discourse surrounding smart cities, emphasising “smart technologies to control informa-

tion flows” as solutions to logistic challenges (acatech, 2011, p.9), can suggest technological determinism and an infrastructure favouring planners and managers. Consequently, citizens’ activities in smart cities risk being “interpreted through a lens of potential profit, not always as actual everyday practices and needs” (Halegoua,

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2012, p.329). A more citizen-centred approach would be to imagine how citizens can leverage the affordances of a smart city to their benefit.

One approach is to consider the presence of pervasive, reliable, high speed networks as enabling novel means of mobile, situated, and contextual learning to a smart city's residents. An emerging paradigm very suited to smart cities is that of incidental learning, which may be understood as "unintentional or unplanned learning that results from other activities" (Kerka, 2000, p.1) ; such learning is not new, but it can now be captured as it happens, supported at the point of need, and used more easily for subsequent reflection and further learning. Where learning can be done via users' smart phones and make use of well-developed network services, a smart city enables mobile devices to become powerful tools for learning.

In this paper we will describe our perspective on incidental learning and how it can offer a valuable approach to providing mobile situated learning in networked urban environments. In particular, we consider one significant urban population, migrants, who face particular challenges and hence may be able to benefit from mobile incidental learning services to support the development of their language skills and social and cultural inclusion. This population is the focus of the MASELTOV project (<http://www.maseltoveu>), in which we are developing a framework for facilitating the creation of technology rich and socially inclusive learning opportunities for migrants within cities. The learning opportunities include everyday practice in using a foreign language and improving one's knowledge through various forms of informal and semi-formal language learning. For migrants, language learning is a critical educational task as it is fundamental to enabling social inclusion (e.g. Marsh, 2002). We consider how this may be supported within situated, contextual learning that uses mobile devices as well as social networks consisting of other migrants, migrant organisations and local volunteers. Successful development of such learning requires different domain experts to come together: educators, migrant support

workers, technology providers, city planners. We are developing a learning framework that may act as a "boundary object" (Star, 1988) to enable sharing of ideas and practical discourse when devising services, in particular between members of very different disciplines. The framework is a descriptive mechanism that permits analysis of mobile, incidental learning, and supports software systems design.

We present our approach to incidental learning and how it is designed to support migrants' language learning needs and social inclusion. We explore how the incidental learning framework is enabling communication between domain experts to develop services that can both address the challenges and take advantage of the opportunities presented by the smart city vision.

First, we will consider how a smart city may enable learning everywhere. We will then turn to consider what mobile learning can be, and how, combined with incidental learning, it can offer a powerful new form of learning to city residents. We consider the particular challenges faced by migrants, and describe the MASELTOV approach, including how a learning framework can support the development of mobile incidental learning services within a smart city.

THE SMART CITY AS AN ENVIRONMENT FOR UBIQUITOUS LEARNING

Advanced networked ICT infrastructures are seen as central to the concept of a smart city (Batty et al., 2012). The smart city vision moves beyond the earlier "digital city" model (e.g. Ishida, 2002) with its emphasis on technological infrastructure, towards "a more complex attitude" considering areas of urban development and management such as economic activities, transport, health, environment and governance (acatech, 2011, p.9). The term "smart" implies that greater efficiencies can be achieved through coordinating and integrating technologies and gaining insight from feedback gathered through

such systems, in order to improve the competitiveness of a city, and improve the quality of life of its citizens (Batty et al., 2012).

While the language of “smart technologies ...to control information flows” (acatech, 2011, p.9) is top-down and technologically deterministic, a more citizen-centred approach may be to consider what it would mean to be a connected citizen, and imagine what the smart city might offer the citizen, rather than what the citizen offers to the city (e.g. Rojas et al., 2008). We believe the smart city can offer a novel means of learning. A pervasive, reliable, high speed public network infrastructure, combined with new configurations of social support and interaction, could afford new ways of educating and informing its residents.

Mobile learning, with its promise of providing “real-time information whenever and wherever learners need it” (Luo et al., 2010) is ideally suited to a smart city environment where a high quality technological infrastructure can be assured. The promise of ubiquitous access to remote services via portable ICT devices (e.g. viewing a web-based social learning platform on a smart phone) has been more of an aspiration than a reality until recently, with the achievement of consistent network access for mobile devices proving to be highly problematic (Gaved et al., 2010). Smart cities are well placed to overcome these technical limitations, and offer a conducive environment for supporting real world mobile learning. Small, portable, network capable ICT-devices such as smart phones and tablet computers are becoming pervasive and central to mobile learning (Traxler, 2009) and enable the extension of learning and teaching across the urban environment (Attewell et al., 2009).

MOBILE LEARNING

Mobile learning can refer to a range of educational approaches: the mobility may refer to learning while on the move, or being able to access learning resources in different places (Brown, 2010). Mobility can also refer to the

learner, or the device. It implies that “learning takes place across space, time, topics, and technologies” (Glahn et al., 2010, p.27). Portable devices such as smart phones and tablet computers allow residents and visitors to learn in context and in everyday life, for example, improving their language skills by retrieving vocabulary related to travel when in a train station, or practicing health related phrases when at a doctor’s surgery. Embedded sensors such as GPS receivers enable mobile devices to be context aware and respond to the environment, triggering context relevant lessons or content when a learner is in a specific location or enters a particular type of building (Ogata et al., 2010). As Foth et al. note (2011), a city wide high quality, high speed network infrastructure augments experiences of place in two contradictory, yet mutually beneficial ways: “wireless, ubiquitous computing allows for interactivity in a place-independent way across physical and geographical boundaries” (ensuring anytime, anywhere connectivity while on the move), while at the same time, “mobile and locative media provide access to place-specific information” (p.2). Klopfer et al. (2002) suggest five features of mobile devices in the context of learning: portability, context sensitivity, connectivity, individuality, and social interactivity.

A smart city high speed, reliable network infrastructure can provide all of Klopfer et al.’s technical affordances, and enable the social aspects. Mobile devices offer learning tools which support learners through networked services (e.g. drawing down content from a remote server, such as emergency vocabulary to help respond to specific incidents in specific places), and also leverage locative data, for example providing location-specific information, triggering resources because of the learner’s location, or identifying the learner’s location to others such as peer learners or tutors to initiate learning or support (e.g. Nova et al., 2005). Learning in context has been argued to be highly motivational for learners (Jones et al., 2006).

Mobile learning can be used in a range of learning modes, formal and informal. It can be used to extend classroom based work into authentic fieldwork environments, support workplace based learning or personal, informal learning. However, one mode which the smart city may be particularly suited to supporting is incidental learning.

INCIDENTAL LEARNING

Incidental learning can be defined as “unintentional or unplanned learning that results from other activities” (Kerka, 2000, p.1), and is an emerging paradigm in mobile language learning (Song & Fox, 2008). In common with situated learning (Lave & Wenger, 1991), incidental learning explores how learning can occur in authentic work and leisure environments, and like informal learning (Livingstone, 2001), occurs outside an externally imposed curriculum. Learning may occur in “fragments” or small learning episodes that are weakly structured (Glahn et al., 2010). It may occur at the point of an ‘incident’, adapting rapidly to a current situation and solve an immediate problem (Silva, 2007), but it can also refer to unexpected learning occurring from observation, conversation or social interaction (Le Clus, 2011). Incidental learning can occur as a by-product of another activity as part of everyday life and so is an ideal form of learning to enable education in everyday contexts. A smart city environment, where mobile devices can reliably and quickly connect to remote learning resources and offer on-the-spot support to an individual’s information needs would be the ideal environment to powerfully support this mode of learning. For example, a visitor in a shopping centre may be able to instantly retrieve vocabulary and key phrases to ask for directions. A resident may decide to find out if there are any volunteer mentors nearby who can offer help with a particular communication difficulty such as asking a pharmacist’s advice about a medical problem, or simply find a friendly language

student who would like to meet in a coffee shop and enjoy practicing their conversational second language skills.

It has been argued that “knowledge from incidental learning develops self-confidence and increases self-knowledge in learning” (Ogata & Yano, 2004); these are in fact important traits that can benefit many citizens, especially those at risk of being marginalised or missing out on available facilities and resources. One group of city residents that may benefit particularly from the availability of incidental learning services are recent migrants.

SUPPORTING LANGUAGE LEARNING AND CULTURAL INCLUSION FOR MIGRANT CITIZENS

Adult migrants have a real need for language learning and cultural inclusion to negotiate bureaucracy, find work and participate fully as citizens (Alajärvi & Anttila, 2012). For example, the correct choice of casual or formal forms of address in conversation is important if you are to be culturally accepted (Ogata & Yano, 2004), and knowledge of specific terminology is required to sit a driving licence exam, which then opens up opportunities for employment (Farinati et al., 2012). Second language acquisition is perceived by adult migrants themselves, as well as host governments, “as a crucial factor for socio-economic and cultural integration” (Kluzer et al., 2011, p.9), with language acquisition and social integration closely intertwined (Van Avermaet & Gysen, 2009). In addition to these very pragmatic reasons for learning a language, there are also symbolic reasons. Language has a strong linkage with identity. In many societies, language is a symbol of belonging. This becomes a complex terrain for immigrants who, in many cases, have to deal with different-dual identities (ingroup-outgroup) and don’t always see in the same way the benefits of learning a new language. However, many adult migrants face personal and work-related constraints on

attending courses, regularly at a fixed time of the day, in certain locations, and in given periods of the year. Furthermore, migrants are a heterogeneous group, with diverse needs and requests with respect to second language (L2) abilities, practice (many immigrants complain of not having real possibilities to practice the host language) and learning paths. Such learners need personalised and differentiated learning programmes that allow them to work at their own pace.

Flexibility in educational provision and delivery is crucial to overcome these constraints. Mobile ICT based learning may therefore provide a very suitable form of education provision for this group (Kluzer et al., 2011, pp.9-10), and incidental learning, occurring during everyday activities, offers a way of supporting language and cultural learning. Mobile phones are particularly suitable as learning platforms as they are already known and trusted by a large number of people and can be used to engage those with lower levels of digital competence, to give them confidence to explore further and “start a learning curve towards more demanding solutions” (ibid., p.11), such as registering for formal, accredited language courses. They are also a means of connecting formal and informal learning, by enabling additional everyday practice and the capture of communication incidents that can be brought back for discussion into a formal classroom. Furthermore, they are suited to semi-formal settings such as groups of learners who gather together in community centres or schools to pursue shared interests or learning goals (Jones et al., 2011).

Noted limitations that have emerged from the analysis of ICT use experiences in L2 education are “poor support of speaking skills and inadequate feedback on mistakes” (Kluzer et al., 2011, p.11) and these may be resolved by a system which incorporates a social learning model, where students can get feedback from peers or mentors. Lave & Wenger claim that social participation in a practice is “the fundamental form of learning” (1991, p.54), while

‘peer learning’, which emphasises the value of interactions among learners, is a recognised approach (O’Donnell & King, 1999).

Such social support has already been applied successfully to language learning by busuu.com, one of the MASELTOV project partners. busuu.com provide web based language learning underpinned by a community approach, where online resources are integrated within a social framework. Language learners encourage each other with feedback and mutual support: as a learning exercise is completed, peers provide feedback and offer suggested improvements to completed tasks. This model operates at scale: currently busuu.com have over 30,000 exercises corrected each day by peer learners. Learning elements consider real world situations, such as asking for help at the doctors, however, while they are accessible on a mobile device, they do not currently provide lessons in context, or take information from the context.

Within MASELTOV, therefore, busuu.com is working with a range of other domain experts to consider how their model might work within an incidental learning mode. We are developing services to take advantage of unplanned, unintentional learning episodes that take place in context in daily life and how we might create a set of services that would support migrants in their language learning and social integration; an approach that would be ideal for implementing in a smart city.

MASELTOV – AN INCIDENTAL LEARNING SYSTEM FOR MIGRANTS

MASELTOV (“Mobile Assistance for Social Inclusion and Empowerment of Immigrants with Persuasive Learning Technologies and Social Network Services”), a three year European Union supported FP7 project started in 2012, has identified the potential of mobile services for supporting language learning, integration,

social inclusion and cultural diversity. We wish to increase migrants' ability to function in an unfamiliar society by facilitating communication and language learning using their smart phones.

We are researching and developing mobile, context-aware tools to enable users to access and interact with essential information and language services, including ubiquitous language translation, navigation, administrative information and emergency health services. Taking advantage of situation and context, we aim to capture user motivation and extend immediate assistance into more structured learning and interaction with other migrants and the wider community, offering services that utilise an incidental learning approach. These offer migrants the opportunity to learn through their daily activities, and draw upon the social and technological resources of a networked urban environment. More than just replicating pen-and-paper learning in the real world, this offers a truly innovative use of smart city infrastructures for citizen centred learning.

The MASELTOV learning services are currently being developed and will be accessible through a central app interface, developed for Android smart phones, which will hold a portfolio of tools. These include:

- **Geo-Social radar:** A volunteer helper service allowing learners to find out if there are any nearby volunteers who can help them with a problem, for example acting as a translator at a doctor's appointment, negotiating local bureaucracy, or simply interested in social conversational practice;
- **TextLens:** a text conversion tool that allows a learner to take a photo of a sign, and have it translated into another language. These can be uploaded into social forum areas for help when the meaning is ambiguous, and if the learner wishes to discuss their cultural or legal implications;
- **Peer reviewed language learning:** a collection of language exercises focussing around everyday tasks. These will offer learning set at the Common European Framework of Reference for Languages (CEFR) A1 and A2 standard, but also

some more elementary material to help very recent migrants with their immediate needs, and those whose language skills are more limited. Like the current busuu.com online learning tools, when an exercise is completed, it will be assessed by a peer learner, and feedback offered. Further discussion of the work will be possible via the linked social forums held within the MASELTOV system and accessible to all learners. Progress will be recorded to a user profile system, and may trigger further content depending on the learner's progress;

- **Mobile navigation tool:** a navigation tool helping with directions, indicating places of interest, and local services. The navigation tool will function like a 'pedestrian sat-nav' giving orientation information, directions, distance to location and best route. Information about important services in the nearby environment will be shown (e.g. pharmacy, doctors, public transport stops). This will be integrated into the other services, so signs found outside public transport can be translated, and may help with meeting up with other learners or volunteers via the geo-social radar. If selected by the learner, proximity to particular locations or types of buildings may trigger learning exercises or in context language support;
- **Profile system:** the user's details and learning progress will be held to allow personalised learning, with the system recommending particular types of content or learning exercises to support each learner's particular needs. Learners can personalise their learning journey by indicating what is important to them, and mentors can identify where particular support can be offered;
- **Social networking and game-based learning:** Users will be able to join a community of fellow learners, and share their experiences. Game-based approaches to increase engagement in learning are an emerging focus in informal learning and we will be exploring how game-based elements may stimulate learner participation.

We believe this has value both to enabling immediate problem solving but also to offer learning episodes that can lead into more structured learning. A person learning another language is trying to acquire common words and standard phrases, as well as gradually developing their capacity to express themselves in more personal ways oriented towards specific communication goals, relationships with target language speakers, and reflective of their personality. Harder (1980) wrote about the “reduced personality” of the second language learner who has a limited linguistic repertoire at their disposal, while recent literature considers this issue in relation to negotiation of identity (Riley, 2006; Taylor, 2011). Identity is a double-edged sword, however. Distinct migrant identities may become noticeable when linguistic uniformity is the norm, as in the example of a school in Beijing (Dong, 2009), and such identities may impact on how migrants are perceived and treated in comparison with others. Self-expression is sometimes outweighed by the need to fit in. Besides, formulaic language is very useful for situations such as predictable exchanges and form-filling within a specific domain. We therefore recognize the dual challenge of conformity and self-expression.

Situated mobile learning offers opportunities to face both of these challenges and migrant learners can use encountered situations to enhance their competences in both respects. Research suggests that there are two main modes of using mobile devices to support informal mobile language learning: as a regular, habitual pattern of activity, and in a spontaneous, unplanned way when the learner reacts to a particular circumstance (Kukulska-Hulme, 2012). Migrants need to prepare themselves for foreseeable situations that they expect to have to deal with, and a MASELTOV service provided on their mobile phone offers a convenient and timely resource for such preparation, which can be done on a regular basis. For example, in the morning over breakfast and on the way into the city centre to carry out a task, the migrant can practise some potentially useful dialogues, words and phrases. In the midst of this task,

or soon after, he/she may become aware of knowledge gaps and difficulties, or notice new vocabulary and colloquial expressions; these may be noted or recorded in a spontaneous way using the recording function on the phone. The expressions may be then uploaded through the MASELTOV system to a social learning area where other learners, and mentors, can offer feedback. A satisfactory level of self-expression is eventually achieved by confronting a range of authentic situations where a personal response is needed. Ros i Solé et al. (2010) remind us that learners use a variety of locations “to enact and rehearse a personal voice” (Ros i Solé et al., 2010, p. 51). Such located experiences can be captured in situ and reflected upon at leisure, for example on the way home (Kukulska-Hulme & Bull, 2009). They can also lead to more active involvement in a language class, when learners bring their recorded experiences into a more formal setting for discussion with each other and with a support worker or teacher.

Kluzer et al. (2011) have identified how ICT based opportunities can offer benefits to L2 education. We build on this to consider how incidental learning in a smart city environment may offer opportunities for these to be presented to migrants as highly relevant, situated, everyday learning experiences, and furthermore, how the MASELTOV services may support these episodes (see Table 1, columns 3 and 4).

Mobile incidental learning can therefore offer a flexible means of learning via a wide range of tools that can be integrated into an overall learning experience. However, tools and services need careful planning if they are to offer useful and pedagogically sound learning. Successful implementation requires consideration of pedagogical, social, technical, and environmental issues. Previous attempts at city-wide mobile learning services have encountered significant challenges (Gaved et al., 2010). For successful implementation, it is necessary to bring together experts from a range of domains: educators, software developers, migrant support workers, urban planners, and following the philosophy of a citizen-centred approach, the intended users themselves. Often

Table 1. ICT-based opportunities to address L2 education challenges, how these may be presented through incidental learning in a smart city, and MASELTOV services which may support this learning (developed from Kluzer et al., 2011, p.11)

ICT-Based Opportunities	Benefits for Second Language Education	Incidental Mobile Learning Applied in the Smart City	MaseltoV Service
Systems supporting personalised guidance and content delivery	Coping with diverse learners' needs and learning styles	Broad demographic of learners with different educational needs	Personalised learning service via profile system
Flexible L2 provision through distance and mobile learning	Tackling time and location constraints L2 learning support at work	Pervasive, reliable, high speed network supports learning at the point of need	MASELTOV services permit structured and opportunistic learning at any time
Automatic and continuous feedback on progress and errors	Support to autonomous learning motivation	Networked services provide instant response via central servers	Learning services and profile system respond to learner's progress
Video- and audio-based resources	Possibility to practice listening and some speaking skills Possibility to (partly) bypass illiteracy barriers	High speed pervasive IT infrastructure supports uploading/downloading of video and audio resources, mobile device can capture multimedia in real environments	TextLens translation of real world image, social network tools for posting of audio and video
Authentic and location-based material	Contextualised, up-to-date and relevant learning	GPS and other sensors in devices triggering learning episode, contextual content based on location	TextLens, Geo-social radar, and navigation tools allow for contextual learning derived from location
Online sharing platforms	Support for teachers' professional development Ready to use material	Networked environment allows access to online resources, peers and mentors at any time in any place	Online social learning environment allows access to resources and peers at all times

such collaborative development processes can be difficult, as each group brings not only their expertise, but different terminology and ways of seeing the world. To elicit the necessary detail required for successful creation and implementation of tools and services, a boundary object (Star, 1988) can facilitate communication.

To facilitate communication in MASELTOV, we have devised a learning framework that will help domain experts interrogate specific learning scenarios, and understand how best to support learners' needs. The MASELTOV Incidental Learning Framework, along with user scenarios, serves as a boundary object.

This boundary object can then define opportunities for informal, situated, social learning and determine the tools, services and features that are needed to facilitate learning and help learners monitor their progress.

MASELTOV INCIDENTAL LEARNING FRAMEWORK

MASELTOV's Incidental Learning Framework considers how incremental, opportunistic, and social learning can best support migrants. Which content areas can be offered, and which technologies are best for each type of content

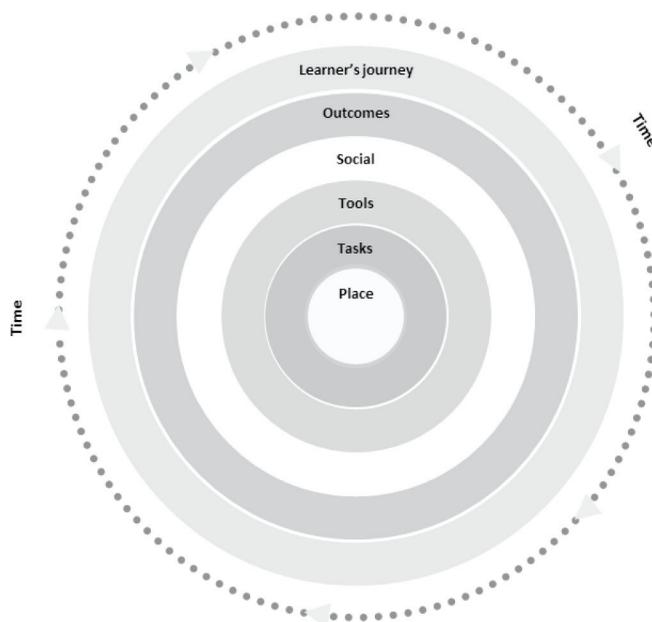
and interaction? What are likely learning scenarios, what social and technical support will they require, and what implications does this have for the design of the built environment? The framework is informed by previous models and frameworks that consider social context (Kukulska-Hulme, 2012), mobile learning (Sharples, 2007), and the support of a 'More Able Partner' (Luckin, 2010). We also consider Kolb's experiential learning theory (Kolb, 1984), and Park's exploration of the social aspects of learning, which proposes mobile devices as mediating artifacts (Park, 2011). Finally, we draw on open learner models (Bull & Kay, 2007) whereby aspects of the system's model of the learner can be made available to the learner to promote learning and reflection.

The framework depicts interactions from the learner's viewpoint. It can show the learner's journey from one incident to another, over time. Incidents can be interspersed with reflection, planning and structured learning, each of which may be triggered by the MASELTOV system. Incidents are characterised in terms of:

- The **place** the incident occurs (and structured learning, planning or reflection); place is not just a location, but also specifies some contextual information;
- The **task(S)** the learner is attempting to carry out;
- The **tools** (including content) the learner can or does use to complete the task;
- The **social support** that the learner can or does make use of; the combination of tools and people is conceptualised as a 'more able partner';
- The **learning outcomes** that the learner wants to achieve, and those that she/he does achieve;
- The (relative) **time** the incidents occur (or structured learning, planning or reflection).

As learning occurs over time, and previous learning outcomes affect the learner's readiness for subsequent tasks, the framework must represent the relative time when learning occurs. Time is not just a specification of an instant or a measurement of a duration, but may also include contextual information e.g. 'lunch time' (Figure 1).

Figure 1. The MASELTOV incidental learning framework



User scenarios enable us to model a likely situation to the framework and examine its challenges. User scenarios are short descriptive stories (Caroll, 2000) that can be used to describe typical situations which a migrant may find themselves, and in our case, how a mobile service may support resolution of a problem. These are being developed through a participatory approach, which we consider important for a citizen-centred city, drawing from the expertise of MASELTOV's three NGO partners who work closely with migrants in Austria (Verein Danaida), Spain (Fundeso) and the UK (Migrants' Resource Centre). These partners used semi-structured interviews to elicit their users' specific needs, and the barriers and challenges they face. The data from the interviews are being analysed to develop user scenarios which can be used to examine the proposed MASELTOV services from a user-centric approach. The user scenario, a story-like narrative, can then be broken down into specific incidents that the designers can reflect on in more detail by mapping each constituent activity onto the framework and consider the implications of each element.

In our discussion of how the Incidental Learning Framework is operationalised, we consider one typical user scenario that could reveal the challenges a recent newcomer to a city might face.

User Scenario: Maria's Journey to Her Relative

One group of migrants in a user design workshop might identify that travelling to unfamiliar locations can be difficult when you only have limited vocabulary of transportation and you are unfamiliar with how the local public transport services run. If there are disruptions, it is difficult to find out information on the rescheduled services, particularly in smaller suburban stations. One participant notes that the language around train notices is unfamiliar, and often incomplete, which requires asking for additional help. The smaller stations in the city are unmanned, so

you cannot ask a staff member for help. You need to be able to understand what the notice says and sometimes ask another member of the public for additional information, for example, which platform a train goes from: sometimes the signs just tell you the rescheduled times but not the rescheduled platforms.

This scenario can be broken down into incidents and learning scenarios to reveal the barriers faced by the participant, and experts can also offer tools and services they feel can resolve the challenges:

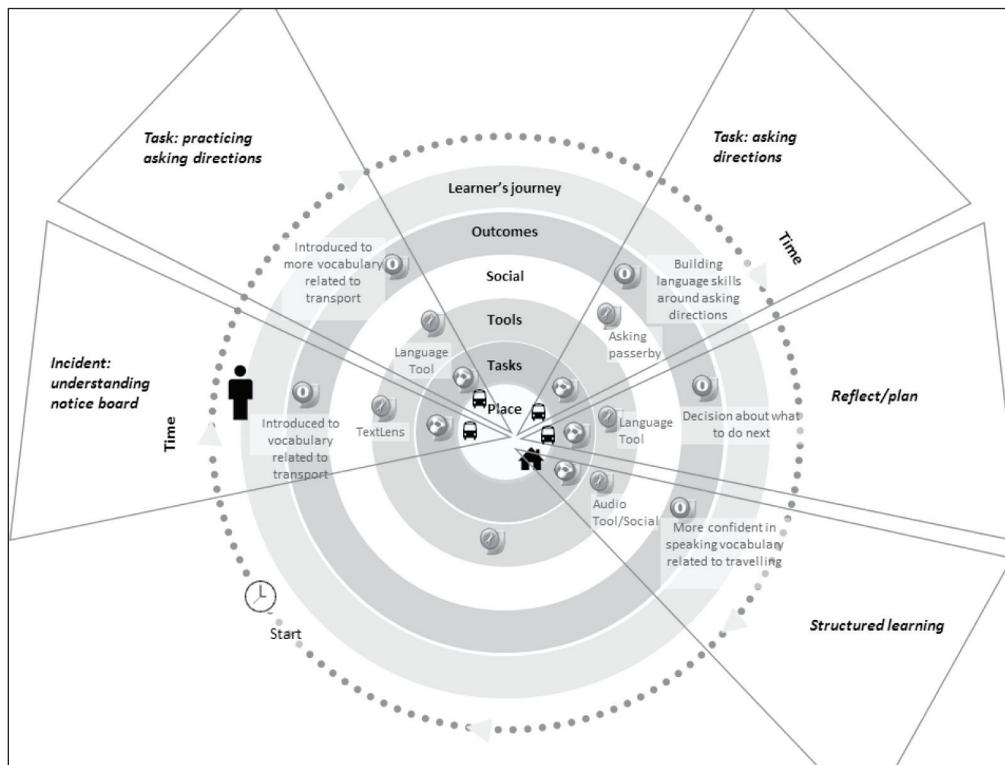
1. Maria needs to catch a local train to a nearby suburb where a local relative lives. When Maria gets to the station, however, she finds that the train times have been changed. She uses the MASELTOV 'TextLens' tool which automatically converts to text any sign she takes a photo of, and translates it (using online translation tools). Maria can now understand that there are some changed train times, and she needs a slightly later train. However, the notice does not tell her which platform the rescheduled train goes from;
2. Maria uses the MASELTOV language tool to find out how to ask somebody where she should get her train from. She uses this to practice the correct phrases;
3. Having practiced some phrases, Maria then asks somebody which platform she needs for her train;
4. When she is on the train, Maria decides she will practise these phrases a little more during the journey. She has been encouraged by her successful negotiation of the train journey. She practices some phrases, recording them as audio files, and uploads them into the shared learning space where other students can listen and offer corrections or improved pronunciations. Maria is taking a coach to visit her friend in another town next week, so this will give her the confidence to ask directions at the coach station.

Mapping this user scenario, with its constituent learning episodes to the Incidental Learning Framework, allows us to see that it exposes that a number of challenges that need addressing to successfully support the learner’s goals, their learning journey, and the successful implementation of the services (see Figure 2).

For example, in the scenario, Maria decides to practise the phrases she has learnt in preparation for later usage. An educator may recommend that a valuable means of testing her phrases will be to practise with another learner, implying that the app should have a social networking dimension: Maria could record some audio samples of her practice and upload these to the learning space where other more advanced learners could listen and offer corrections or improvements. However, presenting this idea for a service reveals to a technical developer, when mapped to the Incidental

Learning Framework, that there is the implied requirement of a network connection, something that the educator might not have considered. This shows that to provide this service, technical developers will have to plan for the possibility that there is no internet connection on the train, and audio files may have to be saved locally and uploaded when a good connection is later achieved. Identifying that network services will be required on trains for this service to operate in real time may prompt city planners to consider whether mobile internet infrastructures have to be improved for transport links: they may reflect that not only these learners, but other residents, may benefit from such a service. The focus group (in the user design workshop) has identified that people would like to practice their vocabulary and phrases while travelling. As a result, the educator might recommend providing feedback to inform and help

Figure 2. Mapping of Maria’s journey scenario onto the incidental learning framework



motivate the learner, so as well as being able to post recordings of key phrases and listen to other learners' versions, some form of feedback or progress indicator might be built into the system. If a number of other learners rate the recording as "good" or above, perhaps the system will then encourage them to try a set of more difficult phrases. Presented with this proposal, exposed in detail through the framework, the technical developer recognises that progress has to be recorded on the learner's individual profile, which may then need scripts to trigger suitable further material. The technical developer can also see that if information about the learner's progress is held within a user profile and can trigger automatic selection of further resources, then an alternative approach might be to notify a mentor that a learner has completed a task or is in need of help. The developer can then raise this possibility with the educator and ask if such an approach is pedagogically valid.

It can be seen that this user scenario could be expanded to consider a broader variety of likely learning episodes that could be encountered in everyday life, and that it is important to have a range of experts, including the intended audience to query the challenges arising. It is also clear that the Incidental Learning Framework helps interrogate scenarios and elicit details, revealing challenges that might not otherwise have been seen.

CONCLUSION

Smart cities offer great potential benefits to their residents as well as city managers. The high speed networked infrastructures designed into such planned environments offer exciting opportunities for novel approaches to the provision of education. The city itself can become a context and a trigger for learning episodes.

We emphasise learning as a lifelong experience, and mobile networked ICT devices enable education to be accessed whenever and where ever citizens wish to access it, throughout their

lives. Educators have proposed a range of mobile learning models, but until recently pedagogical ambitions have often outstripped the practical reality of what networks and ICTs can deliver. However, pervasive, high speed networking infrastructures in smart cities combined with the computing capacity and sensor capability of contemporary smart phones allow the urban landscape to become a learning environment. This opens up education to citizens such as migrants for whom classroom education is difficult to access, or too limited in its scope.

Incidental learning, which draws upon unplanned events in everyday life to initiate learning, is an ideal mode of learning for such residents, and is now achievable in smart cities where networked technologies allow for rich, context-aware learning to take place and to be assessed, supported, and built upon in real time. The social dimension of such learning is crucial, as we have argued, and social networking services can provide peer and mentor support and motivation to progress, whilst continued access to services across place and time allows reflection and further learning.

However, developing such a learning approach is not trivial, and requires a collaborative approach to best understand how to successfully design, implement and deploy services. The MASELTOV learning framework represents a boundary object to allow a range of domain experts such as educators, technology developers, city planners, and citizens themselves to interrogate scenarios, identify challenges, and co-design effective and sustainable models.

Having undertaken initial conversations to understand the information and learning needs of recent migrants into the EU, the project is embarking on a series of user tests of the software services, which will then feed back into further design conversations, improved versions of the Incidental Learning Framework and further iterations of the MASELTOV learning tools app. This participatory, citizen-centred approach is important to ensure that the services under development are most likely to support real citizens' needs.

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