Personal Learning Environments in Smart Cities: Current Approaches and Future Scenarios

With the increasing number of the global population living in densely populated and technologically advanced urban spaces, the notion of smart cities is gaining importance, especially in view of citizen engagement, learning and participation. We propose to consider smart cities as learning spaces and call for innovative pedagogical approaches for using technologies embedded in physical environments to support connected and ubiquitous learning in smart cities. In this paper, we discuss smart cities as spaces for constructing Personal Learning Environments. Our special focus is on mobile and locative media, which open new possibilities of interaction with the surrounding environment. In technology-rich infrastructures such as smart cities, physical objects, including buildings, works of art or points of interest, can become part of the learning environment. When mediated through technologies, e.g. by means of mobile and locative media, the surrounding physical environment and the digital environment can be dynamically merged into augmented, ad-hoc Personal Learning Environments. In this paper we give a short introduction to smart cities, smart citizens and smart city learning, and go on to outline some innovative applications of mobile and locative media in urban spaces, including open badges, smart glasses and mobile tagging, and discuss their potential for learning. Followed by these examples, we discuss educaching as an approach to smart city learning and provide some practical examples based on the example of etiquetAR, a mobile, locative application that allows creating interactive tags to support augmented learning experiences. We then present the results of an international, explorative study on smart city learning, which we conducted with educators from Europe, North America, South America, Middle-East and Asia-Pacific. Based on the synopsis of current research and practice and the results of our study, we argue for an extended view of Personal Learning Environments which are not permanent, but created ad-hoc and adjusted dynamically by connecting virtual and physical spaces in smart cities.

1. Defining Smart City Learning

The notion of “smart cities” has recently triggered a lot of technology-focused discussions and research, including the Horizon 2020 strategy of the European Commission. The Horizon 2020 strategy named several key concerns for the future of the European Union: smart, inclusive, and sustainable growth; security, citizenship and Global Europe; and stimulating interactions between societal challenges and the development of generic enabling and industrial technologies.(COM, 2011). In view of the “smart cities” agenda, Horizon 2020 focuses on smart urban applications enabling innovative solutions targeting energy efficiency (e.g. alternative energy sources), smart transport (e.g. new mobility concepts),

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Tags
smart city learning, urban computing, educaching, glocality, personal learning environments
and enabling technologies (e.g. nano-science, bio-science), but also understanding the social, economic and cultural issues that are involved in the transformation of urban centers into smart cities (COM, 2011, pp. 60-61). Eurocities, the network of major European cities bringing together over 130 of Europe’s largest cities and addressing several policy areas related to living in cities, emphasises the role of smart cities as living labs for market, public, social and cultural innovations (Eurocities, 2012). Smart cities can be also viewed as smart learning environments, i.e. environments which exploit new technologies and approaches, such as ubiquitous and mobile learning, to support people in their daily lives in a proactive yet unobtrusive way (Mikulecký, 2012). In this sense, smart cities as smart learning environments utilize the idea of ambient intelligence by integrating diverse computation, information and communication resources into a united framework of an ambient intelligent space (Cook et al., 2009; Mikulecký, 2012).

Although smart cities can be approached from several dimensions, such as technological, human or institutional (see a complete review about these different approaches in Nam & Pardo, 2011), in this paper we adopt a human-centered perspective. Following the definition by Woods & Bloom (2001), we understand the concept of smart cities as “the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development”. From this perspective, smart cities can be viewed as complex ecosystems supported by technological infrastructures transforming citizen engagement, learning and participation. In our view, the notion of smart cities goes far beyond technologies and technological infrastructures. We argue that smart cities cannot be smart without smart citizens. In order to achieve sustainable societal changes we first and foremost need smart citizens who are knowledgeable and empowered to actively use technologies to transform living environments to smart spaces. As Horizon 2020 points out, building resilient and inclusive societies entails enhancing societal awareness and participation of citizens in decision-making (COM, 2011). We believe that it is necessary to refocus the strategy of smart cities from smart technologies and infrastructures to smart citizens. As Hill (2013) points out, the danger of the smart city vision predicated on feedback loops delivering information to influence citizen attitudes and behaviour is that citizens may become passive in response to technological infrastructure becoming active.

Refocusing the concept of smart cities from smart technologies to smart citizens is also closely linked to learning in smart cities. This issue has been just recently raised as a response to current smart city policies. The initiative on Smart City Learning and the related International Observatory on Smart City Learning are dedicated to the future of learning in smart cities and intend to foster a change in the current reflection on smart city learning (Giovanella, 2013). In this context, a number of articles propose new conceptualisations of smart cities: Giovanella et al. (2013) emphasize citizen involvement with the city and propose to consider cities as “open libraries” containing a huge number of resources, such as buildings or artworks, that can be used for learning; Calori et al. (2013) suggest to think about smart city learning as a navigation of trajectories in terms of space, time, roles and resources, which can be supported by connecting episodes across past, present and future experiences; Sintoris et al. (2013) propose the notion of “technology enhanced places”, i.e. places with embedded technologies, supporting new kinds of learning, especially constructing contextual knowledge by moving and operating in an authentic environment; McCullough (2013) emphasises the importance of attention in the context of ambient urban computing. He proposes embodied cognition, making use of environmental features as building blocks for thought, as a framework for smart city learning.

Inspired by the concepts outlined above, we define smart city learning from a human-centered perspective as the learning experience of locally and globally interconnected citizens who use smart technologies to learn by using, sharing, remixing and co-constructing learning resources, and in this way actively contribute to solving societal, environmental, political and economic challenges. From this perspective, the “smartness” of the learning environment is determined primarily by the citizens and their uses of smart technologies rather than technologies themselves. Derived from the technological viewpoint of “smart” as expressed by Poslad (2009), we define smart learners as active, networked, autonomous and in control of own resources. The proposed conceptualisation of smart city learning is thus akin to participatory urbanism, i.e. uses of “emerging ubiquitous urban and personal mobile technologies to enable citizen action by allowing open measuring, sharing, and remixing of elements of urban living marked by, requiring, or involving participation, especially affording the opportunity for individual citizen participation, sharing, and voice” (Paulos et al., 2009). While participatory urbanism focuses on engaging in grassroots efforts including citizen science, smart city learning is a broader term and encompasses formal, informal and mixed learning experiences in urban spaces.
2. Extending the view of Personal Learning Environments

Technological advancements, such as positioning systems, wireless technologies, ubiquitous computing and the increasing adoption of mobile technologies, allow citizens to connect anytime and anywhere, linking remote places, resources and people. This pertains not only to urban but also increasingly to rural and remote areas. In smart cities, however, technological infrastructures and digital ecosystems build far more complex and advanced interconnections, opening new opportunities for constructing Personal Learning Environments. The rapid adoption of connected technologies, devices and networks across growing urban landscapes has been termed as *urban computing* (Paulos et al., 2009). With the ever increasing number of urban citizens (with approx. 75 % of the global population living in urban centres), the growth of digital infrastructures and the proliferation of interconnected personal digital tools such as smartphones and the recently emerging wearable computing, traditional physical constraints of time and space transcend and the notions of sociality, spatialization and temporalization have to be redefined (Golloway, 20014; Paulos et al., 2009).

Taking as point of departure Meyrowitz’s concept of “glocality” and Cereau’s concept of “practiced places”, we propose a conceptualization of Personal Learning Environments (PLE) as permeable physical and virtual spaces, which are dynamically constructed through the subject’s practice of movements across physical and virtual spaces. While understanding “space as a practiced place” (Certeau, 1988), new media and technologies expand our practice, or the “movements of everyday life” beyond the local. As our “practices” in physical and virtual spaces become interlaced, our spatial experience changes: “We live in glocalities, where the local and the global coexists” (Meyrowitz, 2005). However, no matter how sophisticated technologies are, “the localness of experience is a constant” (Meyrowitz, 2005, pp. 21). As human beings we cannot detach ourselves from our local, physical experience, but as we use technologies, the localness and the virtuality of our experience become tightly fused. This happens for example when we move in a physical place (e.g. city), which is a relational environment with different elements distributed in a coexisting relationship (Certeau, 1988), with a group of people (e.g. students) using mobile devices (e.g. smartphones, tablets) to interact with subjects (e.g. social media users) and objects (e.g. digital content) which are not within our immediate physical proximity. In this sense, PLE are constructed through the practice of “movement” across spaces. Sharples et al. (2009) differentiate between mobility in the physical space, mobility of technology, mobility in conceptual space, mobility in social space and mobility in time, as different types of movement in terms of “flows across locations, times, topics and technologies”. We believe these notions are applicable to constructing Personal Learning Environments, especially with mobile and locative media. By moving across spaces, contexts, concepts and time we are able to capture and share our personal learning experiences in new ways. For example, from the perspective of *ubiquitous computing* encompassing smart devices, smart environments and smart interactions (Smart DEI), learners in smart cities are provided with enhanced mobility, interaction and control possibilities (Poslad, 2009), all enabling new forms of learning across *multiple contexts*.

In this respect, Pérez-Sanagustín et al. (2013) propose three central attributes of technologies capable of supporting smart city learning. These include *multi-channel, multi-objective and multi-context learning*. First, technologies for smart city learning have to support *multi-channel learning*, which is an active and participatory process engaging diverse agents and supporting multi-directional conversations in multiple channels in the smart city ecosystem. Second, technologies for smart city learning have to support *multiple-objective learning*, which supports learners in following personal, idiosyncratic objectives and learning patterns. Third, technologies for smart city learning have to support *multi-context learning*, which enables not only learning anywhere and anytime, but also combining physical and virtual spaces transforming urban elements into learning resources (Pérez-Sanagustín et al., 2013).

Thus, we can think of constructing Personal Learning Environments in smart cities as *blending spaces* that together create opportunities for learning in networked and integrated urban infrastructures (Sharples et al., 2013). In smart cities, personal resources may be augmented with infrastructures and data embedded in the city by using personal devices such as *smart phones*, *smart watches* or *smart glasses*, all capable of enhancing our interactions with both physical and digital world. Based on the key principle of Personal Learning Environments, it is the learner that becomes the main actor in such augmented spaces. In smart city learning, learners may transform multiple spaces into a personal environment for learning by both interacting with the environment and connecting to other learners in order to receive, share, remix and co-create information.
As the “Innovating Pedagogy 2013” report points out, the new emerging learning experiences take on diverse pedagogical forms (Sharples et al., 2013). Thereby, seamless learning, crowd learning, geo-learning or citizen inquiry seem to be especially relevant in the context of smart city learning. Seamless learning describes an emerging pedagogical practice of connecting learning across settings, technologies and activities. As a pedagogical method, seamless learning aims at creating a seamless flow of learning experiences across such contexts as formal education and daily life. Seamless learning results from learners extending their personal technologies for learning across times and locations, blending learning with everyday life (Sharples et al., 2013). Crowd learning focuses on harnessing the knowledge of many people and utilizing “the power of the masses” to support learning experiences. By applying mobile technologies in crowd learning, the information flows between the crowd and the learner, and the expertise of the crowd can be accessed anytime and anywhere on learner’s personal device. In this sense, crowd learning transfers ownership of the learning process to the learner but at the same time requires tools and mechanisms to guide learners, recognise their progress, and reward contributions (Sharples et al., 2013). Geo-learning refers to learning in and about locations. Geo-learning can take place both indoors and outdoors, and utilizes context-aware and position-based technologies for mixing physical and digital elements. In geo-learning experiences, the technology is used to add interactive points and layers of digital information to physical spaces, which offers the possibility of interconnecting locations and social settings, as well as facilitating the exchange of information across contexts. Connecting contexts may be seen as a way of stimulating seamless learning, for example by moving themes explored in the classroom to outdoor settings and flowing back to the classroom to enrich lessons (Sharples et al., 2013). Finally, citizen enquiry as a pedagogical approach combines inquiry-based learning and citizen activism in order to support creative knowledge building, citizen investigations and scientific practices of social value (Sharples et al., 2013).

These and other new pedagogical approaches may be applied to support smart city learning. Since any moment in the city can become a “learning moment”, in which people can relate their knowledge from different contexts, constructing Personal Learning Environments becomes ad-hoc and dynamically adapted by the learner to the current context rather than pre-designed to equip the learner with necessary tools to cope with upcoming situations. From this perspective, ubiquitous learning, i.e. detecting and identifying the surrounding context to provide guidance, resources and collaborators for learning (Yang et al., 2009), provides new reference points for conceptualising Personal Learning Environments in context of smart city learning. These include but are not limited to mobility, location awareness, interoperability, seamlessness, situation awareness, social awareness, adaptability and pervasiveness (Yang et al., 2009).

3. Smart City Learning Practices

Given the new technological opportunities and pedagogical practices, this section outlines some of the current applications of emerging media in urban spaces. Then, the results of an international, explorative study which aimed at eliciting educational scenarios in context of smart city learning are presented and discussed from the perspective of constructing Personal Learning Environments.

3.1 Digital Badges

3.1.1 Open Badges

Badges are symbolic representations of an accomplishment, skill, quality or interest (Knight & Casilli, 2012). Digital badges have become popular due to geolocation services such as Foursquare, which award users with badges for check-ins at different locations. More recently, Open Badges, an initiative of Mozilla and MacArthur Foundation, have explored badges as elements of learning and applied badges to set goals, stimulate motivation, recognise and represent achievements, and communicate learning success across contexts, supporting open credentialing and accreditation for formal and informal learning (Knight & Casilli, 2012). Open Badges are designed to build a badging ecosystem with badges being issued and displayed across different contexts and learning environments to form living transcripts of learners’ skills and competencies (Knight & Casilli, 2012). As such, Open Badges offer a flexible mechanism not only for motivating learners or recognising achievements but also for communicating personal accomplishments, skills and evidence of learning across diverse learning spaces. In this sense badges can be viewed as boundary objects, crossing boundaries between existing divisions such as formal and informal learning or academic and professional achievement (Buchem, et al., 2011). With tools and infrastructures for badging constantly improving, there is yet much room for educators to explore new approaches to using badges for learning (Sharples et al., 2013).
3.1.2 Example: Chicago Summer of Learning

Among numerous examples of supporting motivation and recognising achievement in online learning environments (Santos et al., 2013), there have yet been few examples of using badges to merge the physical and virtual learning spaces in the context of smart city learning. The first citywide implementation of a badge ecosystem was the Chicago Summer of Learning (CSOL, 2013). In 2013 the City of Chicago incorporated badges to support learning in the city building on partnerships with youth-serving organizations, museums and cultural institutions, philanthropists, businesses and citizens. Young people in Chicago could explore, play and learn with the different organisations and citizens by following exploratory challenges, making own projects, developing skills and earning badges throughout the smart city learning experience. The Summer of Learning in Chicago focused on Science, Technology, Engineering, Arts and Mathematics (STEAM) and enabled young people in Chicago to gain learning and work experiences using the city as a learning environment. By earning badges, participating citizens could unlock citywide challenges which supported the development of new skills by connecting to people, building real-world artifacts and communicating achievements across learning contexts by publicly displaying badges. Chicago Summer of Learning with its applications of online and locative media allowing for embedding learning in smart cities, supported learners in constructing Personal Learning Environments on-the-go. Students could construct their Personal Learning Environments ad-hoc, by combining online and in-person experiences as well as using technologies for collaboration and recognition of learning and achievement through Open Badges. Partnering with schools, enterprises, families and community organisations and allowing students to create and navigate multiple learning pathways, allowed to blur traditional divisions between formal and informal learning and to explore new learning opportunities by connecting physical and virtual learning spaces.

4.2 Smart Glasses

4.2.1 Google Glass

Google Glass is one of the most popular augmented reality (AR) wearable computing products. With augmented reality applications becoming commonly available to the general public, mainly due to technological advances in mobile computing and sensor integration, educators and learners can seize new opportunities for learning (FitzGerald et al., 2012). For example, AR browser applications, including Wikitude, Layar or junaio are used by smartphone users to explore the surrounding environment, such as finding new, interesting places, events and activities in close proximity. Other AR applications, such as the Google Goggles application for smartphones that enables search based on visual recognition, and Google Glass including an AR view with overlaid contextual information, enable users to search, record and share what they are seeing in the surrounding environment. These and other AR applications rely on the context as a critical aspect of supplementing or augmenting the physical surroundings through additional, overlaid information, thus blending reality and virtuality into what is called mixed reality (FitzGerald et al., 2012). Mobile uses of AR allows the blending of physical and virtual environments based on an ever changing geographical position of the user, serving as a mechanism for personal or individual experiences. As such, mobile AR may enhance not only spatial but also temporal mobility, enabling learners to use resources on-the-fly, at a time and place convenient and relevant to them (FitzGerald et al., 2012). While AR applications have been used in such fields as medicine or mechanics, only recently educators have started to explore educational uses of wearable technologies based on AR. Wearable AR, such as Google Glass, enable learners to take the learning experience outdoors, such as in smart city learning, allowing for situated learning including situative embodiment as proposed by the embodied cognition approach (Barab et al., 2007).

3.2.2 Example: STEMbite

The Google Glass device as a wearable technology operated by voice commands enables the user to connect to internet services, contacts and social networks, record video and display information in a hands-free mode. Google Glass may provide educators and learners with new possibilities for hands-free perspective media capture and augmented networked learning experiences (Hayes, 2012). Some of the first explorations of Google Glass in education is STEMbite by Heuvel (2013), an educator selected as Glass Explorer by Google, teaching live physics lessons using Google Glass. As part of this teaching experience - STEMbite - a YouTube channel with a series of bite-size videos have been set up to show the math and science of everyday life from a unique first-person perspective (Heuvel, 2013). It is the shift in perspective, from watching a lecturing teacher, to seeing as if through the eyes of a teacher, that allows for new teaching and learning experiences. Another
example includes the transmission from the Large Hadron Collider at CERN in Switzerland to students in the USA. This type of educational transmission from an eye-level perspective allows both educators and learners to capture the surrounding environment and participate in real-time activities. In this way, learners can construct Personal Learning Environments by linking physical and virtual learning spaces and participating in glocal learning activities, including virtual field trips with embedded communication with both local and remote peers, educators and experts.

3.3 Mobile Tagging

3.3.1 Educaching

Thanks to such technologies as Global Positioning Systems (GPS) or tag-based augmented reality technologies including Quick Response (QR) codes, physical spaces can be transformed into digitally augmented spaces where the digital and the physical merge. These technologies, in combination with the software on mobile devices detecting the position of the user and providing context-aware learning depending on the location, offer new opportunities for learning based on the principles of geocaching. Geocaching appeared as a treasure hunting game with a GPS-enabled device in a physical space in the late 1990s. Geocaching has been played throughout the world by adventure seekers equipped with GPS devices, called geocachers, who locate hidden containers, called geocaches, in physical outdoor settings and then share their experiences offline and online (Zecha, 2012). In the recent years, geocaching has developed as an approach to designing localised learning activities, which utilize the benefits of ubiquitous computing in outdoor settings. The geocaching concept, methods, and tools have been making their way into education under the name of educaching (Dobyns et al., 2007). Educaching encompasses a range of applications and scenarios, such as providing learning content in caches which can be found with the help of location services, also in form of mobile learning games, linking physical surroundings to digital learning content.

3.3.2 Example: etiquetAR

etiquetAR is a web-mobile-based application for generating interactive tags to support the design and enactment of mobile learning experiences (Pérez-Sanagustín et al., 2013). etiquetAR is based on the idea that digital tags, e.g. QR codes, can work as digital layers of information that extend and transform physical spaces into digitally augmented learning spaces. The etiquetAR application includes a set of functionalities that are especially suitable to support smart city learning. First, etiquetAR allows users to create own tags with the image of a QR code linking physical objects to multiple digital resources. Users can create interactive tags linking with one or a list of resources, all associated with a particular profile that learners can select when creating tags. The profile functionality allows users to adapt their learning path according to own needs or interests. Second, tags generated with etiquetAR can be read with any QR code reader, allowing users with diverse devices with different operating systems to participate in learning. Third, etiquetAR tags can be commented on, which enables users to contribute new ideas and opinions about resources associated to a particular code. The comment functionality allows for micro-blogging and in this way supports conversations as part of smart city learning. Since anyone can generate tags attachable to any urban element, urban spaces can be transformed into blended spaces, which at the same time can be extended by anyone in the city. etiquetAR can be used as a service for generating indoor and outdoor learning experiences based on educaching and analysing the type of scenarios that emerge from its usage. In this context, etiquetAR tags act as geocaches that are distributed and attached to objects in the city. Tags can be generated, personalized and commented on by any user, allowing for the generation of communities of knowledge associated to particular urban spaces. In this way, etiquetAR can support multi-directional conversations through multiple channels allowing learners to engage in multiple communications and follow multiple learning paths.

3.3.3 Constructing Personal Learning Environments

Most educaching scenarios, such as environmental education (Zecha, 2012), involve the uses of GPS technology to situate the geocaches and guide the learners along the interactive adventure. However, the potential of tag position-based technologies such as QR codes or near field communication (NFC) tags for educaching experiences in closed places such as museums has not yet been fully explored. Moreover, compared with other position-based technologies such as GPS that directly show resources when the user is positioned in a particular location, tag position-based technologies are especially interesting in learning situations in which a voluntary user-information interaction is expected. In this context, tags can be seen as digital layers of information allowing for an ad-hoc construction of Personal Learning Environments. By enabling learners to discover different places
and dynamically constructing learning spaces, educaching promotes ubiquitous, playful and exploratory learning in both outdoor and indoor settings. As such educaching can be seen as an approach to constructing Personal Learning Environments (PLE) by connecting local and global perspectives (glocality) and moving across different physical and virtual places (spaces). In educaching experiences, learners construct their knowledge by solving game-like challenges and creating game-like challenges for other learners, using various tools to localise physical objects and relate digital information to these objects, as well as by interacting with other educaching participants, both within and outside of physical proximity. Based on the understanding of Personal Learning Environments (PLE) as self-directed uses of technology by the learner to support own learning (Buchem et al. 2011), educaching involves appropriation of tools and resources by the learner, who constructs own spaces for learning by selecting, aggregating and creating resources from physical and virtual spaces.

4. Exploring Scenarios for Smart City Learning

In order to understand how educators envisage constructing Personal Learning Environments in context of smart city learning, we conducted an international, exploratory study with educators from around the world. Altogether 16 educators from different higher education institutions in countries in Europe, North America, South America, Middle East and Asia-Pacific participated in the study and contributed their ideas and visions on smart city learning. The study consisted of two parts, both based on an online survey, in which educators were invited to reflect about possible smart city learning scenarios. In the first part of the survey, related to possible uses of etiquetAR for educaching in context of smart city learning, five selected educators were asked to describe (1) a use case scenario using etiquetAR, including its main objectives, who would participate and what activities they would perform, (2) how learners would create their PLE in their scenarios and (3) what the personal environment would be composed of. Three exemplary scenarios elicited in the first part of the survey are presented in Table 1.

Table 1: Examples of educaching scenarios elicited in the first part of the study

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<th>Question</th>
<th>Educators’ answer</th>
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| EDUCATOR 1 | Setting: I would like to design and run a connectivist MOOC (cMOOC) on learning technologies. As part of the logo of this MOOC there will be a QR code generated with etiquetAR. Every week I would suggest a topic for discussion. Students may discuss online but also gather physically in groups at different locations in cities. One of those participating in the physical meetings will print the logo of the course and use it as a banner stuck on the wall at the meeting place (e.g. a cafeteria or pub). After the discussion one of the participants will scan the QR code, adding the main conclusions of that meeting as a comment to the question posed by me (the instructor). That will happen in all the cities where learners gather for face-to-face discussions.  

Objectives and theme: Discussing about given questions on learning technologies (e.g. the role of MOOCs nowadays, the potential of mobile devices in face-to-face classes). The theme would be Technology Enhanced Learning.  

Participants and roles: Me (instructor) in the role of facilitator for the discussions. Learners as the ones who actually discuss selected topics.  

Activity plan: Weekly face-to-face meetings and online discussions.  

Organization: I will pose a weekly question, analyze the conclusions of the discussion in every face-to-face group, analyze the contributions in further online discussion, and then I will set my own conclusions.  

Complementary social media tools: Foursquare and Meetup for organizing the meetings; Facebook and Twitter for further online discussions.  

(2) Learners PLE creation | There is no central platform like an LMS in this MOOC. The contributions to the course are distributed across a number of web 2.0 tools. |
**Question** | **Educators’ answer**
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**(3) PLE composition** | The PLE will be constructed using Foursquare, Meetup, Facebook, Twitter and some other tools that students will want to add by their own initiative.

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**Question** | **Educators’ answer**
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**EDUCATOR 2** | **(1) The scenario**

**Setting**: The context of my informal learning scenario uses etiquetAR in a technological fair. The different exhibitors are tagged using etiquetAR so that a visitor can approach them and know more about the technology or service exhibited. There are several profiles of visitors: techies, businessmen, investors, etc. Each of them will have personalized information from the tags, as well as a communication channel by means of the comments.

**Objectives and theme**: The concrete learning objective depends on the learner profile. It is different for a techie and a businessman. But some common objectives are to be aware of new technologies and services in their field, find out what other participants think about them, and collect enough information about them to further explore/investigate the most relevant.

**Participants and roles**: In this informal learning setting, there will be learners (the visitors) and a basic learning content (the info about the products and services) provided by the vendors, that is used by the organizers to tag the exhibitors in the fair.

**Activity plan**: As previously described, the main activity would be for the visitors to walk around the fair, find out more about the products and services, and provide comments about them to share with their profile peers. Once the fair is finished, the information collected would help them to choose some products and services to investigate in depth.

**Complementary social media tools**: Social media could be used jointly with etiquetAR to detect trendy products in the fair. An integration of one of them, for example Twitter, with etiquetAR comments would be nice to open the conversation about the products and services to the world.

**(2) Learners PLE creation** | The visitors create their PLEs by deciding which exhibitor resources to visit and what media tools to use in order to be part of the conversation. With the personalized information collected (e.g. links, tutorials, interesting comments), visitors can continue learning after the event. Maybe some of them will report about what they learnt in the fair to their bosses using etiquetAR and social media.

**(3) PLE composition** | The learning resources would be the information associated with the exhibitors, as well as the interaction with the salesmen. It is an unstructured learning setting, in which the learners (visitors) decide about the next learning steps, creating their Personal Learning Environments as they move on.

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**Question** | **Educators’ answer**
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**EDUCATOR 4** | **(1) The scenario**

**Setting**: Adapting a physical environment to support language learning.

**Objectives and theme**: The theme would be a location-based and multilingual learning experience focusing on vocabulary learning. The objectives would be to learn the vocabulary of more than one language.

**Participants and roles**: Teachers would have the role of resource creators. Learners would have the role of participants in one or more languages.

**Activity plan**: 1. Checking for information of an object in the physical space; 2. Providing more information about an object; 3. Performing an assessment about the information of an object.

**Complementary social media tools**: Probably a learning management system.

**(2) Learners PLE creation** | By providing more information, either general or contextual, about each object in the physical space.

**(3) PLE composition** | The physical space, the objects that can be visited, commented and assessed about.
We analyzed all five educaching scenarios proposed by the educators as summarized in Table 1 in relation to three research questions related to smart city learning addressed in the first part of the exploratory study, i.e.: (1) What types of educaching scenarios can support smart city learning? (2) What types of uses of tag-based technologies can support construction of PLEs? (3) How can etiquetAR provide guidance for PLE construction in educaching scenarios?

Regarding the first question about the type of educaching scenarios designed to support smart city learning, we could derive three main characteristics of smart city learning scenarios:

1. Smart city learning scenarios combine exploratory learning activities carried out in informal or non-formal outdoor and indoor settings, combining both open and closed physical locations with online environments. Such exploratory learning activities occur in several spatial locations in which learners can freely explore mediated interactions.

2. Smart city learning scenarios promote discussions and reflections about physical spaces with the learning objectives being to actively interact with other ideas and context of other learners, such as contributing comments to proposed tags. Discussions and reflections aim at making learners aware of physical objects in different locations by providing information adapted to individual profiles.

3. Smart city learning scenarios are learner-centered, where the learner plays an active role in each learning activity with teachers acting as facilitators in the activity. Learners play the role of contributors adding comments and ideas to complement information provided by peers.

Regarding the second question related to the uses of tags supporting the construction of Personal Learning Environments, we could see that teachers propose the construction of PLEs composed of social media tools in combination with the use of interactive tags, as created with etiquetAR. Especially, educators view tools such as Facebook and Twitter as part of educational scenarios, followed by uses of Learning Management Systems, wikis and other web 2.0 tools.

Regarding the third question about the type of guidance provided by tools such as etiquetAR for supporting PLE construction we could identify three different generic strategies, i.e.:

1. **Constructing PLEs by interacting with people**, mediated by technologies, such as tags, as a communication channel to receive and leave information. An example of this type of strategy is the scenario proposed by Educator 2, in which visitors to a trade fair learn by connecting to other visitors and exhibitors, e.g. by leaving comments about different exhibits.

2. **Constructing PLEs by interacting with objects**, mediated by technologies, such as tags, adapted to user profile. An example of this type of strategy is the scenario proposed by Educator 4, in which students receive information in different languages about an object in the city.

3. **Constructing PLEs by interacting with tools**, mediated by technologies, such as tags, in combination with other web-based tools. An example of this type of strategy is the scenario proposed by Educator 1, in which students can use complementary tools integrated in a MOOC.

In the second part of the survey, we invited selected educators to describe their visions of future smart city learning scenarios with emerging technologies, including badges, augmented reality and wearable computing. Several exemplary scenarios elicited in the second part of the survey are presented in Table 2.

The analysis of the second part of the survey reveals some key technologies envisaged by educators to play a central role in supporting smart city learning. These include pervasive technologies, augmented reality, mobile tagging including QR codes and geotagging, digital badges, mobile social media, smart objects and wearable computing including Google Glass. To sum up, the first exploratory results about possible smart city learning scenarios together with the educaching designs proposed by educators, are the first evidence indicating that a wide range of emerging technologies, going far beyond web 2.0 or social media, may be used to support learners in constructing their Personal Learning Environments in the context of smart city learning.
Table 2: Examples of smart city learning scenarios with emerging technologies.

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<th>Technological focus</th>
<th>Educators’ scenario</th>
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<td>(1) Pervasive technologies</td>
<td>Learning in smart cities will mostly be constructed out of short fragmented interaction with pervasive technology serving as a consolidating umbrella by documenting, aggregating and connecting discrete interactions into a larger whole, allowing for revisiting, self-reflection and ultimately, for a deeper learning experience. Learning will become highly personal and personalized, embedded sensors will become prevalent both in the learners’ environment (i.e. the city) as well as physically embedded on the learners body and on wearable items, allowing for technology to serve as a true extension of the self, collecting explicit and implicit cues from the learner for the purpose of highlighting, mediating and supporting learning opportunities. Learning, with the mediation of pervasive technologies, will have a social context as learners will increasingly become a part of a connected group of learners, be it their real life peers or ad hoc groups of learners who share a common interest or simply a common location.</td>
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<td>(2) Open Badges</td>
<td>Well, let me try to imagine a learning scenario in smart cities. I think (or I hope) that in the future each person will have his own device to learn (1:1). Nowadays we can see many students with notebooks and smartphones and a few students with tablets. Internet connection will be provided by cities for everyone and everywhere. In the future, city learning will be supported by localization in context, e.g. the system will recognize learner’s location and provide adequate information, helping to find people who have similar interests and indicating appropriate learning resources based on the context. Especially, technologies such as Open Badges will be used to communicate expertise (including non-formal expertise of non-scholars), and will be supported by game-based approaches such as gamification which, together with social networks, will be integrated into curricula and considered as part of the learning environment.</td>
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<td>(3) Mobile Tagging</td>
<td>Learning in educational contexts will be different. For example learning about geography, such as climate change, population growth, demographic changes or urbanisation will be supported by using different geo-localisation apps on mobile devices. As far as learning about history, QR codes will be attached to different places and historical information will be displayed with the help of AR applications. In civic education, learning about neighbourhoods will be supported by e-badges displayed in bus stations, supermarkets etc., transforming open spaces into places for learning about the city. SNS will be used to support learning about policies, local governments, to post pictures and trace places of local interests, mapping events and public transportations with geo-localisation apps. QR codes will be used to open the appetite for learning. For example, chains of QR codes will be used to support storytelling and team-based adventures.</td>
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<td>(4) Augmented Reality</td>
<td>In the future we will learn history in a different way. A historian will be able to analyze developments of a given battle way back in time. Historians will be able to visit a battlefield and not only reenact history by using augmented reality, but also change the conditions under which the battle took place, change the compositions of the armies, change the hour of the day, the weather ... and learn how it all affected one side or the other side’s victory by actually seeing it, not just being told about it and having to believe it. In this train of thought, augmented reality used for simulation will automatically lead to experimentation. With a major difference - so far experimentation has been something mostly reserved for experimental sciences. Augmented reality can definitely contribute to bringing experimentation into social sciences. More than providing contextual information, we should be thinking on how augmented reality can bring knowledge into many fields of science and learning, by enabling simulation and, thus, experimentation in many fields and situations. The main limitation for 3D environments was that input still used to be 2D, e.g mouse movements over the screen. With augmented reality, input can match output and a 3D environment enables a full and comprehensive learning experience. And this will surely change the way we work, have fun and, of course, learn.</td>
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<td>(5) Smart objects</td>
<td>I guess that in the future the locations/objects themselves will present people/groups different and challenging learning opportunities. I also believe that the technology involved will not be intrusive because natural interfaces will be used. And yes, that kind of challenge will be drawn by educators but also by learning peers as I believe that learning and assessment/validation will suffer major changes and that peer assessment will be increasingly important. I believe the future will bring new and totally different teaching and learning scenarios in which objects will be able to communicate with us and with other things in order to create exciting learning opportunities. I think that in near future students will be able to directly interact with objects and that those objects will be, in a “real” sense, learning objects, posing challenges and providing exciting learning opportunities to them. One example of something that we are currently working on: the idea that in a chemistry lab you can learn through direct manipulation and interaction with lab objects, learning all the security procedures needed to use them. The idea is to use natural interfaces and invisible computing techniques.</td>
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<td>(6) Google Glass</td>
<td>In the future we will use opportunities of wearable computers for improvement of educational processes (e.g. Google Glass videos for young teachers). We can collect video data about best practices from leading educators at universities (e.g. Youtube channel “Google Glass in professional practice”). For example, young surgeons (or students of medical faculty) will be able to watch through Google Glass video how experienced surgeon performs open heart surgery. Also young educators (e.g. faculty of education) will be able to watch how leading lecturer interacts with the students in the classroom. Young teachers can observe the behavior of the lecturer (voice volume, direction of gaze, movement in the classroom). It will be possible to see how students react on different methods of teaching. That means Google Glass give us opportunities to watch from teacher’s side on professional situations. And every young teacher around the world by video channel “Google Glass in professional practice” will be able to improve his/her teaching skills.</td>
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<td>(7) Mobile social media</td>
<td>Mobile social media is inherently collaborative, but requires a significant rethink of assessment design, utilizing collaborative user-content generation tools such as Vyclone for collaborative video. In the future, lecturers will engage with and model the educational use of mobile social media within the curriculum. This requires reconceptualizing mobile social media from a purely social domain to an academic and professional domain of use. For example: Google Maps or Google Earth will be used as a collaborative platform to collate/curate student projects from around the world, where student teams link their geotagged content within a shared Google Map. This adds the dimension of authentic context to student projects, with the ability for students around the world to share in the experience of learning of others within the original context. Linking geotagged content from a variety of new and emerging mobile Apps makes this a relatively simple yet dynamic and collaborative experience. Example Apps include: Vyclone for collaborative video recording, the online YouTube video editor for collaborative video editing and annotation, Flickr, Instagram, and Picasa for collaborative photo sharing/curation, Junaio for embedding QR tags within augmented reality etc. Academic rigour can be achieved by requiring students to annotate their content using accepted referencing styles, yet turning this into a collaborative curation activity via creating shared Mendeley or Zotero libraries etc. Specific activities will depend upon each student’s context, and should be student negotiable, however the collaborative element of such projects needs to be clearly defined, as student experience of being active members within an authentic professional global community of practice is one of the goals of such projects.</td>
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Discussion

Current technologies allow the transformation of smart cities into augmented spaces for learning in which constructing Personal Learning Environments is happens ad-hoc and is adjusted dynamically to individual learner’s context. The challenge is to understand how Personal Learning Environments may be constructed as part of smart city learning. In this paper, we have reviewed some of the current techno-pedagogical approaches and practices in the field and presented our understanding of smart city learning. Based on the preliminary results of our international, explorative study we could identify three key generic strategies for constructing Personal Learning Environments in context of smart city learning. These include constructing Personal Learning Environments by interacting with people, objects and tools. The review of current literature and the results of our explorative study suggest that the conceptualisation of Personal Learning Environments in the context of smart city learning has to be extended to the view of PLEs as merged physical and virtual learning spaces which are constructed ad-hoc as learners move across spatial, temporal and conceptual contexts. To support learners in constructing their Personal Learning Environments in context of smart city learning, we need to understand what pedagogical strategies and technological uses could be most effective to do so. In this paper we have introduced educaching with a mobile tagging service etiquetAR as an example of a combination of pedagogical approach and technological application supporting smart city learning. This paper is just a preliminary exploration of smart city learning. We intend to elicit further scenarios across various educational contexts to understand what emerging technologies and pedagogical approaches could be employed to support learning in smart cities.

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References


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