Multi-channel, multi-objective, multi-context services: The *glue* of the smart cities learning ecosystem

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Abstract. Smart devices in combination with other digital tools have occupied the cities transforming citizens' urban experience. People are connected any time and anywhere with their global identities changing their relation to the local. People live in *glocalities*, where the local and the global co-exists. *Glocalities* are unique and constantly changing in a lifelong-learning process in which the citizen is in the centre. There is an urgent need for services to support *glocal*, reciprocal and multi-episodic lifelong learning processes in digital urban spaces. In this paper we define three key attributes that these services has to fulfil for being the *glue* to connect and guide the complex technology-enhanced learning ecosystems in smart cities: multi-channel, multi-objective and multi-context. Finally, we give an example of these types of services and contribute with an illustrative *glocalised* learning scenario showing how life-long learning processes would be supported in smart cities of the future.

Keywords: Smart cities learning, multi-channel, multi-objective, multi-context, lifelong learning.

1 Introduction: learning through *glocalities*

Cities are complex, networked spaces where people work, learn, play, organise in communities, do shopping, go running or simply have a coffee with their friends. These activities involve daily experiences that are strongly dependent on the nature of a specific locality. With the increasing availability of smart devices in combination with other electronic advances, technology has occupied the urban space transforming cities into smart places. Cities have become complex organic ecosystems supported by a technological infrastructure that is transforming the way we engage with the city [1]. Within this urban space we can connect any time and anywhere to remote places, resources and people (with our global identity) when engaging in diverse activities. We extend the boundaries of our experience by using digital media as we cease to see our physical surroundings as the only centre and source of our experience and identity.

The connection with the global also changes our relation to the local. We can choose our own networks for membership and level of engagement in each network to shape our urban experience [2]. In smart cities, we live in *glocalities*, where local and global co-exist [2]. There are as many *glocalities* as there are people. Each *glocality* is unique and is constantly evolving, influenced by the global and the local. What happens is a fusion of local and global experiences and identities. We process information from the city with information from our global identity generating urban conversations that influence other *glocalities*. We are lifelong learners that are permanently learning with and within the media-networked city. As we continuously create and modify our "multiple, multi-layered, fluid, and endlessly adjustable senses of identity" [2], the key question becomes: *How can we use technology to support our learning and making sense of distributed knowledge between the global and the local diversity, while participating in an ever evolving, lifelong learning process within smart cities ecosystems?*

Glocalities evolve as people use technology to build their learning ecosystems through which they can immerse into the continuous flow of information. Diverse agents compose such immersive urban learning ecosystems, e.g. city institutions as information providers, citizens as collectors, producers and sharers of information, urban elements as local sensors for providing and collecting information. All these agents can be technologically enhanced to participate in urban conversations. **What we needed are services that interconnect all agents and orchestrate the ecosystem, both integrating technologies involved and mediating the information flow**.

In this paper we argue that multi-channel, multi-objective and multi- context services are the necessary *glue* for connecting and guiding the complex technology-enhanced learning ecosystems in smart cities. First, in section 2, we present the three key attributes of the *glue* services that support learning in the smart city ecosystems. In section 3 we describe etiquetAR [3] as an illustrative example of a *glue* service to support reciprocal and multi-episodic learning in digital urban spaces. etiquetAR (that means *labelling* in Spanish) is a web-mobile-based tool for generating learning experiences based on tags. Then, in section 4 we present an example of smart city learning scenarios in which etiquetAR is used as a *glue* services for augmenting urban spaces to support learning about the culture of different countries. Finally, in section 5 we present the main conclusions and discuss about the new research avenues derived from this work.

2 Key attributes of *glue* services to support smart cities learning

This section presents key attributes that are necessary for a service to act as the *glue* for mediating conversations between the agents of the urban ecosystem and transforming them into a learning process. As learning in smart cities becomes *glocal*, reciprocal and multi-episodic, the challenge is to design a service catering for the evolving nature of individual and connected *glocalities*.

We define three attributes that define a *glue* service (Fig. 1):

(1) **Multi-channel:** Learning in the smart city is an active and participatory process engaging diverse agents in the ecosystem. Ideally, citizens and institutions cooperate to build up the knowledge of the city in a collaborative democratic and egalitarian process. Thus one of the central ideas related to multi-channel cooperation is *crowdsourcing* [4]. Smart cities learning include mechanisms supporting diverse crowdsourcing technologies and initiatives with the aim of promoting creative and innovative processes that affect the daily life of the citizens.

Smart cities need *glue* services able to support multi-directional conversations through multiple channels to allow agents to create and choose different *identities* and engage in diverse communication patterns. Only having multi-channel services it is possible to assure an egalitarian and democratic dialogue between agents in a urban ecosystem. Supporting multi-channel conversations allows agents to flexibly mash evolving channels and identities while participating in collective knowledge construction.

(2) **Multiple-objective:** Smart cities are not only about groups, but also about individuals. Learning is a process, which is both individual and social. Learning is embedded in a social context with each learner following personal objectives, learning rhythms and patterns. Learning services for the smart city need to cater for individual idiosyncrasies in order to be *inclusive* and involve individual citizens in the knowledge construction.

To face these differences and idiosyncrasies, we need *glue* services able to support diverse objectives, which guide individual and multiple learning paths. As learning objectives emerge from conversations between agents in the ecosystems and learning itself becomes multi-episodic, we tend to struggle with multiple learning tools and interfaces. Supporting multi-objective learning paths means guiding agents in building these paths by connecting multiple sources and technologies. This mechanism is closely related to the concept of *big data* [5], where large and complex data sets are available to construct diverse learning paths. In view of the large quantities of information, the use big data to support multi-objective learning paths involves capture, curation, search, sharing, analysis and visualization of data available to learners in smart cities.

(3) **Multi-context:** Learning in the smart city means learning anywhere and anytime. Cities need to be transformed in learning environments in which the digital information is combined with the physical space to support citizens in their life-long learning process. Urban elements are transformed into resources and smart devices into the mechanisms to access the knowledge hidden into these elements. Therefore *augmented reality* [6] technologies and services, which enable additional information to be overlaid on surrounding, real spaces

and objects are valuable for enhancing the perception of the surrounding urban environment, enabling new ways of interaction and exploration of urban spaces.

Exploration of the environment however cannot be limited to the augmentation and display of additional information, which is pre-determined by others (e.g. experts, owners, decision-makers), but has to include possibilities for self-determined discovery of information by individual citizens. Especially fostering *serendipity* by enhancing chances of valuable discoveries in urban spaces is crucial for personally meaningful learning and development of critical skills. Serendipity, that is making fortunate, unplanned but meaningful discoveries, is an important element of any creative process and plays a crucial role in gaining new insights, generating new ideas and revealing connections between elements. Serendipitous learning is not simply about creating randomness [7]. The crucial element is supporting individuals in recognizing patterns of seemingly accidental events, building connections between seemingly unrelated information and evaluating implications of such discoveries.

Therefore *glue* services of the smart city have to support individuals in recognizing patterns, creative opportunities and potentials of seemingly random information, possibly relating virtual and physical to transform the global and the local into *glocal*. As both physical and virtual spaces act as filters contextualizing information, supporting multi-context conversations between agents in the urban ecosystem is a challenge for creating *glocalized* smart cities learning scenarios of the future.
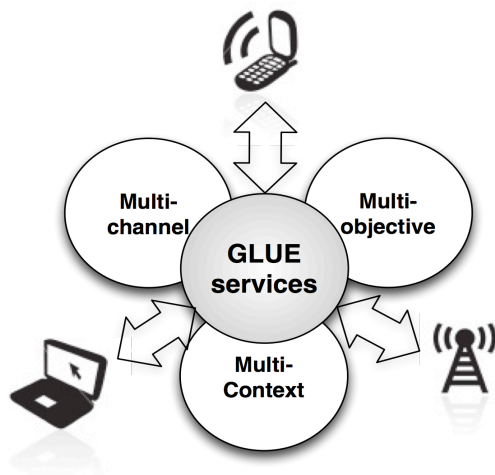

Fig. 1. The three attributes of a *glue* service for supporting learning in the smart city: multi-channel, multi-objective and multi-context.

3 etiquetAR: an example of a *glue* service for learning in the smart city

etiquetAR is a web-mobile-based tool for supporting the design and enactment of mobile augmented learning experiences based on tags [3]. etiquetAR is based on the idea that digital tags (such as QR codes or NFC cards) can work as digital layers of information that extend and transform physical spaces into digitally augmented spaces. In this section, we describe the main functionalities of the first prototype of the tool and discuss what makes etiquetAR a *glue* service for supporting learning in the smart city.

3.1 etiquetAR, a web-mobile-based application

etiquetAR is composed by two applications: (1) a web-based application for supporting creation, personalization and management of tags and (2) a mobile-based application for accessing the information hidden in the tags. You can sign up for the first prototype of the tool here: http://www.etiquetar.com.es.
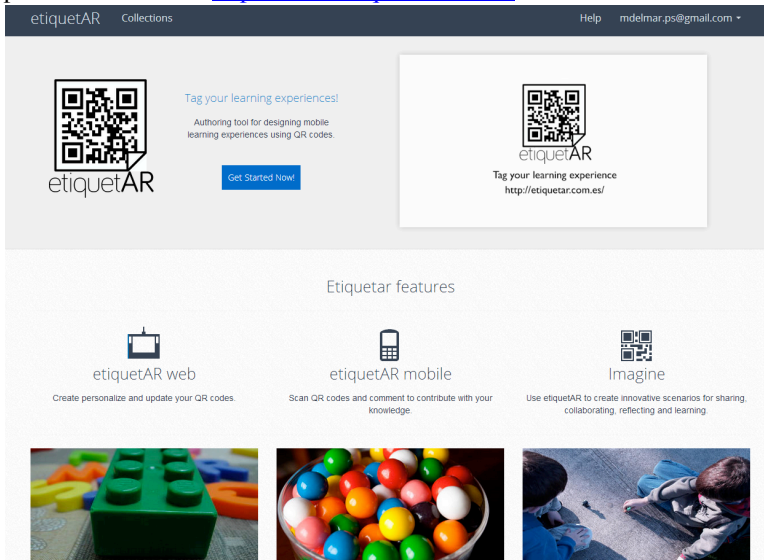

Fig. 2. Home page of etiquetAR web-based tool.

The **etiquetAR web-based** application includes three functionalities (Fig. 2):

1) *Creating a tag*. Users can create as many tags as they want with the following information: the name of the tag, the name of the resource that they want to store in the tag, and the URL where the content to be shown in the tag is stored.

2) *Linking resources to a profile*. The user can relate each of the resources

related to a tag to a profile. The profiles are used to personalize the information attached to the tag. For example, a user can add to the same tag one resource for users aged between 10 to 12 and one resource for user aged between 14 and 16.

3) *Printing the tags*. Once the tags are created, the user can print and attach the tags to any location for augmenting a physical space with digital information.

We are currently working in the second version of the tool, which would include three new functionalities. The first functionality will enable the user to associate, not only on-line resources to the tag but also, text, pictures, videos, questions and files. The second functionality will enable the user to associate Geo-spatial coordinates to their tags to indicate where the tags are located within the city. Finally, the third functionality will enable the user to create collections of tags and share them with other users in order to support the co-edition of tags.
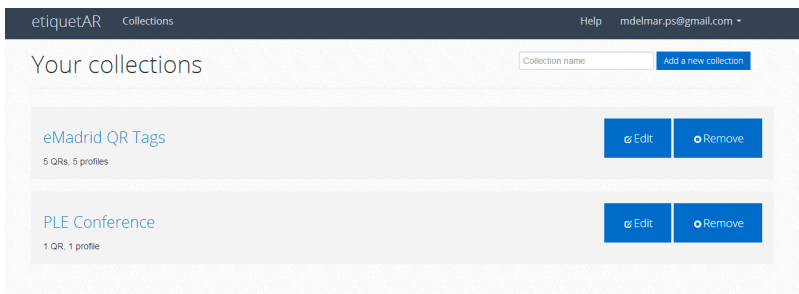

Fig. 3. Page where the user manage the tags: create, edit and link resources.

The **etiquetAR mobile-based** application enables:

1) *Reading the tag*. etiquetAR does not require any specific application to read the tags. Since the tags are generated using the QR standard [8] any QR Reader can be used to access the tags information. Users can interact with the QR reader installed in their devices without installing any special application.

2) *Selecting the appropriate profile*. When reading the tag, two situations are possible depending on how the tags were created. First, if the tag is associated to one or more resources, but no profiles are specified, the user will be redirected the first resource associated to the tag, the default resource. Whereas, if the tag has different contents associated to different profiles, the user is re-directed to a landing page that contains a profile selector (Fig. 4). The user would select the profile more amputated to his/her needs and access the information related.
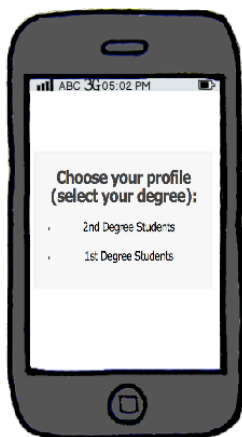
Fig. 4. Profile selector launched when reading a tag with different profiles.

Currently, we are also working on a functionality that enables the user, not only accessing and selecting the information from a tag, but also adding messages related to this tag *in situ*.

3.2 etiquetAR as a *glue* service

etiquetAR is an illustrative example of a multi-channel, multi-objective and multi-context *glue* service for creating and sharing interactive learning experiences based on tags. The tags generated with etiquetAR can be attached to any urban object or location in order to augment their properties with global information and convert them into objects for structuring learning paths and supporting *glocalized* scenarios.

First, etiquetAR is a **multi-channel** service because it provides the citizens with the mechanisms to easily generate tags with personalised content that augment and extend the properties of urban elements. Tags are transformed into the key mechanisms for supporting knowledge construction since their content is shared with other people when attached to a particular object or location and accessed by any other user. Second, etiquetAR is a **multiple-objective** service because tags can contain resources for different profiles. Profiles are the stems for supporting multi-objective learning paths that will guide and connect users to multiple technologies and sources adequate to their particular objectives. And third, etiquetAR is a **multi-context** service because the tags are the mechanisms to relate physical spaces with virtual information being the open access to the glocalities. Tags can be used in any context and, always, will be relating global information to the local place where they are located.

4   Glocalised learning scenarios in smart cities of the future

This section describes an illustrative example of a *glocalise* scenario in smart cities. This scenario is based on etiquetAR as the *glue* service for structuring the city conversations using tags as the learning support that augment and extend urban spaces. In this scenario, the tags act as the elements to trigger citizens' action and measure citizens' intentionality, since they capture when a citizen interact with the tag and which are their interventions to the urban conversation. In this context, QR codes behave as the "citizen sensors" that use citizens' interactions to capture their intentions, worries and interests about the urban context. Therefore, etiquetAR provides the Technological ecosystem for supporting and structuring the conversations of the 'smart-cities' lifelong-learning scenarios of the future.

The scenario presented is called *Breaking myths* and describes how cultural institutions can be transformed into spaces for prompting cultural dialogues across countries. This scenario has been designed to show how citizens are empowered when provided with *glue* services. But this scenario is only an example to inspire other researchers in the design of the smart cities learning scenarios of the future.

4.1 Re-thinking cultural spaces: *Breaking myths*

Breaking myths is a scenario that puts citizens in the centre of a discussion about cultural and historical aspects of three European cities: Paris, Berlin and London. The main objective is to involve citizens from different countries in a discussion about the emblematic areas, buildings or elements of the city to break prejudices and learn about other cities history and culture.

Two main actors are involved in this scenario: students and citizens from Paris, London and Berlin and the urban elements of the three cities that are going to trigger the discussion. Students from the different countries would create tags associated to a set of emblematic buildings of elements in their city, such as the Eiffel tower in Paris or the Brandenburg Door in Berlin, and locate them in areas nearby to these buildings. The tags would be generated using the profile functionality of etiquetAR and associate them two different resources: (1) information about the building and (2) a blog where citizens from other countries ask questions about the myths that these elements represent in their country. Students from Berlin and London will access etiquetAR via web to add questions to the tags generated by the students in Paris. These questions should be related to the myths and prejudices that they have about that building. For instance, a student from London could ask in the tag related to the Eiffel tower, *¿is it true that the Eiffel tower inspired the Blackpool tower?* The tag, since located in nearby areas of the building, could be accessed by any citizen. Citizens would have the possibility of answering the questions related to that tag using the blog. The student owner of the tag, in this case from Paris, should have to write and update the information about the building to answer the questions prompted

by other students and the information provided by other citizens.

In this scenario, etiquetAR is used via web to make other students to participate in the discussion (**multi-channel**). At the same time, the tags are placed in the different buildings or urban elements involved in the discussion to localize the global information (**multi-context**) particular locations. Finally, any citizen can also participate from the generated conversation or by accessing to the information generated or by giving information to the open questions (**multi-objective**).

5 Conclusions & discussion

This paper has presented the relevant attributes to be considered in the design of the services to support *glocal*, reciprocal and multi-episodic learning in digital urban spaces: multi-channel, multi-objective and multi-context. We argue that the services fulfilling these attributes are the *glue* for supporting the learning ecosystems of smart cities. Then, and as an example of a *glue* service, we have introduced etiquetAR. EtiquetAR is a web-mobile-based tool for creating and managing tags as the mechanisms for supporting augmented learning experiences within the smart cities. Finally, we have presented an illustrative scenario to exemplify how etiquetAR could be used for supporting *glocalised* smart city learning scenarios of the future.

The three attributes of *glue* services presented poses some open challenges to be explore in relation to learning in the smart city. On the one hand, to set the characteristics of the services supporting learning in the smart city is a starting point to understand the way people learn and how they build their learning paths. On the other hand, to understand the characteristics of the services supporting learning opens up new avenues to think about the type of smart city learning scenarios that we can support. We think that the ideas presented will help on advancing technology-enhanced learning while facilitating integration in mixed educational contexts of the smart city.

Acknowledgments

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