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Learning Activities in a Sociable Smart City

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Abstract. We present our approach on how smart city technologies may enhance the learning process. We have developed the CLIO urban computing system, which invites people to share personal memories and interact the collective city memory. Various educational scenarios and activities were performed exploiting CLIO; in this paper we present the methodology we followed and the experience we gained. Learning has always been the cognitive process of acquiring skills or knowledge, while teachers are often eager to experiment with novel technological means and methods; our aim was to explore the effect that urban computing could have to the learning process. We applied our methodology in the city of Corfu inviting schools to engage their students in learning through the collective city memory while exploiting urban computing. Results from our experience demonstrate the potential of exploiting urban computing in the learning process and the benefits of learning out of the classroom.

Keywords: mobile learning, urban computing, smart city learning, collective city memory.

1 Introduction

Learning has not changed over the years from being the cognitive process of acquiring skills or knowledge, but the means and methods used in the learning process have evolved reflecting the advent of technology. Not so long ago, a radical change occurred in early 1990s; it was the evolution of the traditional class to the e-class that followed the emergence and popularity of the Web. A number of e-learning platforms and systems were designed with various levels of usability. Simple ones managed and distributed educational content, full-fledged learning management systems promoted interactivity; both could be based either on synchronous or asynchronous communication.

The next great breakthrough occurred just before the millennium with the adoption of mobile phones; their initial use was as common wireless telephone devices but soon they evolved to much more than that as people used them to view their emails, watch the news, browse the web, etc. Significant contribution to their adoption had the increase of their capabilities; they converged to small computers as they adopted OS with more capabilities, bigger screens, multiple communication interfaces, lots of memory, etc. All these promoted their adoption as devices suitable for learning; thus an ecosystem of mobile learning systems and applications flourished. Mobile learning

is not only restricted to a specific curriculum but can be also applied to informal learning, as this appears in museums, campuses, etc, exploiting smart phones and tablets.

The latest evolution sprang off the research in the early 2000s on ubiquitous computing, which was envisioned by Weiser [1] who defined it as a technology that can be seamlessly integrated into the everyday environment and aid people in their everyday activities. Technology has become embedded in everyday objects, like furniture, clothes, vehicles, roads and smart materials; people, as Weiser foresaw [2], are "continually interacting with hundreds of nearby wirelessly connected computers" and inhabit smart cities. People can exploit the setting of a smart city in the learning process, as educational content is offered from multiple sources even when they are not pursuing it. Smart city learning escapes indoors settings, like schools and museums, occurring in informal outdoor settings, like city walks, tourist assistant applications, etc. Exploiting information that characterises the current situation of learners, educational content and places, altogether the context in which learning occurs, enriches the learning process.

This evolution and especially mobile and smart city learning enables teachers to get their classes out of their classrooms, facilitates learners to continue their learning in the city landscape and allows realisation of the learning process when and where they desire. Learning activities are no longer confined to formal learning in the classroom, but can be carried out through the city via exploration and interaction. Teaching methods like projects and field trips can benefit from these technologies as they can enrich the smart city learning experience.

In this paper we present how smart city technologies may enhance the learning process using as a case study the CLIO urban computing system, which invites people to share personal memories and interact the collective city memory. We describe learning scenarios and activities learning through the collective city memory and the methodology we followed with schools from Corfu, Greece. We discuss our evaluation results and conclude presenting our vision for learning in a sociable smart city.

2 Background

Mobile learning is "any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" [3]. Ubiquitous learning on the other hand means something more than mobility, a ubiquitous learning environment is any setting in which students can become totally immersed in the learning process [4]; it is a setting of pervasive learning that is happening all around the student but the student may not even be conscious of the learning process. In extension, smart city learning leverages the infrastructure and services that modern smart cities offer in order to transform them into open learning environments.

A number of mobile learning applications have been used in various contexts, like schools, and universities. In [5] various examples of teaching and learning with

mobile technologies are categorised under the perspective of the learning theory that each follows. In [6] mobile learning and training projects are described under the prism of selected features, like context, aims, technology and outcomes. In [7] mobile education projects, applied both in high schools and universities, are analysed regarding infrastructure, devices and educational processes.

Ubiquitous learning is based on the idea of "always on" education that is available anywhere, at anytime [8]. A key concept of ubiquitous learning is the social interactions that occur wherever and whenever [9]. A number of context-aware ubiquitous learning systems and applications, like ActiveCampus and ActiveClass, Ubi-campus, JAPELES, Oxygen, etc., have been evaluated [10] exhibiting the benefits of ubiquitous learning.

Teachers acknowledge the value of learning outside the classroom exploiting novel methods and technologies [11], [12], [13]. Modern smart cities offer the necessary infrastructure and services to foster a number of formal and informal learning activities in the city landscape. Following we present our proposal on how an urban computing system may leverage the learning process.

3 Learning through the Collective City Memory

Memory is the mental capacity through which events are stored, preserved and recalled in mind; it is in permanent evolution, open to the dialectic of remembering and forgetting [14]. The relationship between memory and society has been identified by Halbwachs [15] who suggested that memory is a matter of how minds work together in society, as "it is in society that people normally acquire their memories" and "it is also in society that they recall, recognize, and localize their memories". He introduced the term "collective memory" to express the social contextualization of all individual memories.

Space plays an important role in shaping the collective memory [15], since it is in the space, which we occupy and traverse, that our understanding of the past is preserved. Nora [14] identifies that the modern way of life has disconnected us from our past, thus we consciously cultivate sites of memory (les lieux de mémoire). As Huyssen [16] mentions we are searching for and building places of memory that can provide a sense of "temporal anchoring". Boyer [17] considers that a city can be regarded as a collective memory. Cities are places where events that have occurred during time are projected and various aspects are expressed through personal memories and narrations. Lately, Crinson [18] introduced the term "urban memory"; urban memory is a kind of collective memory constituted by individuals' experiences within the place itself and through its history and social environment [19].

Collective city memory, as any kind of collective memory, ultimately is located not in sites but in individuals and their will to remember; therefore it can contribute to retrieve lost ambience in urban sites due to the constant change of the physical environment as time goes by. Collective city memory is an important aspect of the cultural heritage of a city; thus it should be captured, recorded and preserved for the next generations.

Capturing the collective city memory starts with collecting and recording individual memories; these can be expressed through narrations, photos or drawings, published or confined texts and videos. Personal memories, once recorded, have to be annotated by locating them into the city landscape and positioning them in time. The collective city memory is formed via the interrelations among individual memories based on the time they occurred, the space they refer to, the story they present, etc.. The process of capturing individual memories and transforming them into the collective city memory entails a significant learning value and various learning activities may be carried out. The collective city memory can be a valuable learning source for young students as well as adult learners, who can acquaint themselves with their city and its local history and tradition.

3.1 Learning Scenarios

Following we present a number of representative learning scenarios exploiting the collective city memory into a smart city environment.

Sharing personal memories and enriching the collective city memory: "John, a former mayor of the city, walks with his granddaughter around the city. Passing by the ruins of an old church, his granddaughter asks him if he knows which church was located there. John recalls not only the name of the church, but also how it was destructed during the Second World War. His granddaughter decides to record his narration with her smart phone and share it enriching the collective city memory."

Learning from the collective city memory: "A group of 13 years old students has an assignment to identify the occupations of the past, to locate where they were held in their city and take photos of the current conditions. They walk around the old part of the city and using their smart phones they access the collective city memory. Passing from places where the jobs of the past took place, memories associated with these professions are retrieved and attached photos show how the space used to be."

Exploring a city: "A group of 16 years old students explore the city to identify architectural features and how these are related to local history. They wander around the city and identify code tags (2D QR codes) in various buildings. They can scan these codes with their smart phones, follow the link using the city WiFi network or a 3G network and view the memories associated with the buildings."

A treasure hunt game via an augmented reality environment: "Groups of 17 years old students navigate their city physical and digital environment via an augmented reality application on their smart phones. Their target is to collect as many "points" by visiting parts of the city, which have changed radically in recent years identifying buildings that do not exist or their use has changed."

4 CLIO: Interacting with the Collective City Memory

In an era when information can be easily captured, recorded, preserved and accessed, the collective city memory, an important aspect of our cultural heritage, is vanishing. Personal memories pass on to younger generations via narrations accounting for

events that occurred in the past or describing daily life; the audience is usually family members or a narrow social group. Therefore, in time, valuable recollections are isolated and lost along with their carriers. In other cases, the accuracy of these memories is skewed as the physical place changes and transforms thus erasing their points of reference in the landscape. The CLIO system was created aiming to invite people to share their personal memories, to allow the interactions among these memories transforming them into the collective city memory and to preserve this aspect of a city's cultural heritage. CLIO is an acronym for ColLective cIty memory, inspired by the Ancient Greek mythology muse Clio, whose name derives from the Greek verb kleo (Greek: κλέω/κλείω) which means to "recount", "narrate", and "make famous".

CLIO is an urban computing system [20], [21] that transforms individual memories into collective ones and infuses them into the city landscape allowing an interaction among memories that simulates the traditional way in society that people share memories via conversations. It allows people to share pieces of memories using simple text or rich multimedia, to identify associations among memories, to rate them and to explore the city through them.

Memories shared on CLIO consist of a number of media files, like photos, audio or video clips and text, along with context information like the location and time they refer to, relevant events, etc. CLIO also stores tags that are attached to the memories, comments that viewers add, ratings and statistics. Context information about each memory is then exploited to categorize a memory in themes.

CLIO is designed as a context-aware urban computing system [20], [22]; it stores memories and their context information and then uses user context in order to present him with relevant memories. A number of applications are offered allowing users to interact with the collective city memory via several interfaces exploiting smart mobile devices and smart city infrastructure.

4.1 Recording and Sharing Personal Memories

The first public interface of CLIO was web based, as we wished to have a simple, familiar interface suitable for the general public and accessible via their personal computers. Anyone could share a memory via the i-recall tool, Fig.1, using a web-based form that could be launched on a standard pc browser; a memory could be a narration, a photo, a video, a text or any combination of these.

The sharing process is a three-steps one. On the first step the user selects a title for the memory and adds the content media. These can be text, images that are directly uploaded or linked, a link to a video or, finally, an audio that is uploaded. The second step requires the user to locate the memory. The user can select a point of interest, which is already stored in the system, or insert a new point of interest and locate it on the map. On the last step the user can provide a set of tags that describe when, where and to what this memory refers to and optionally personal information.

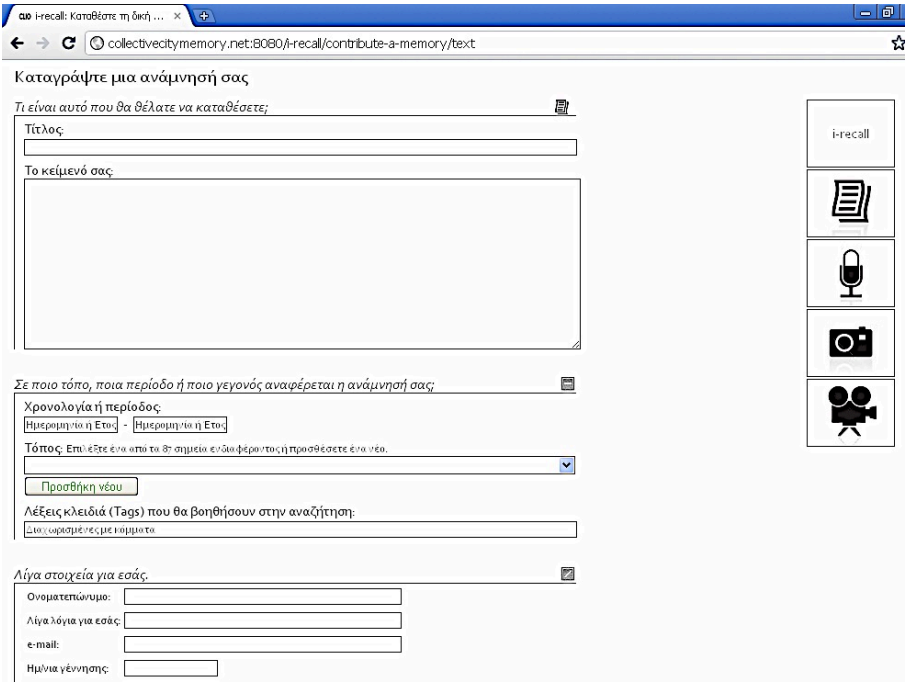


Fig. 1. Sharing a memory via the i-recall tool; the user may share a memory in various formats, like text, audio, photo, video or their combination.

4.2 Browsing the Collective City Memory

The first web-based interface of CLIO allowed people to interact with the collective city memory through a familiar medium and browse memories based on standard map and tag cloud views.

The map view, Fig.2a, emphasizes on the location context of each memory focusing near the user's current location. The user can zoom in and out the map as well as pan by dragging the screen, in order to view other areas of the city, and select a marker to view a memory. The word cloud view, Fig.2b, emphasizes on the context of each memory based on the tags attached to each memory. It presents categorised themes, extracted from the given tags for each memory; tags are of size proportional to the number of memories that are related to them. The user can rotate the word cloud and select a theme that interests him. When a user selects a marker on the map or a word on the cloud to view a memory, its full description appears, Fig.3.

(a) (b)

Fig. 2. (a) CLIO map view with markers for each memory, (b) CLIO word cloud view with tags and memory titles.

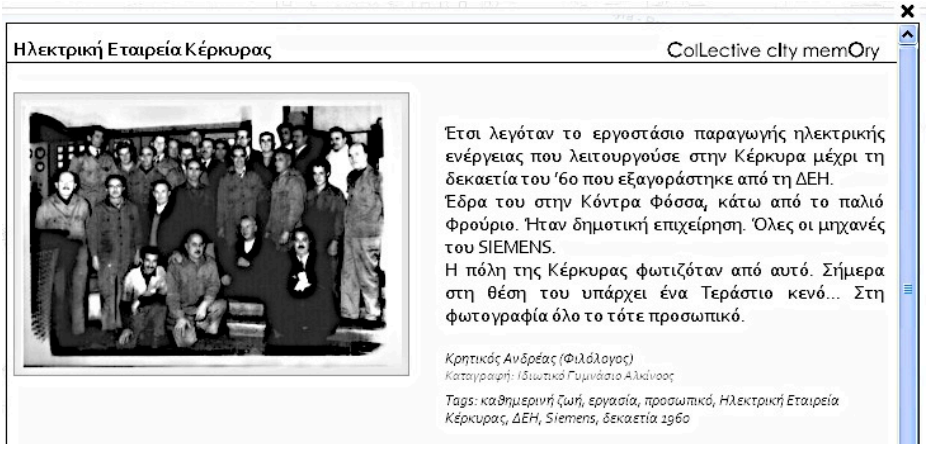
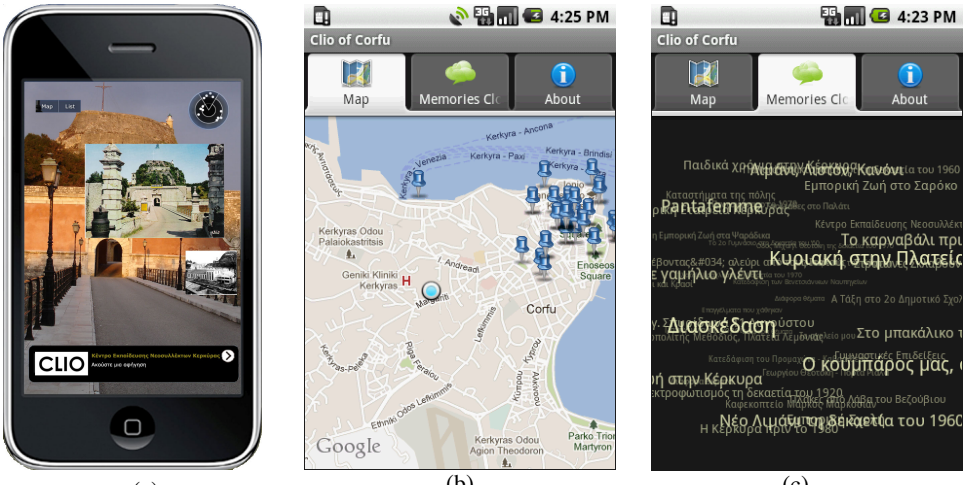


Fig. 3. Presenting a memory; it appears the photo, text and context attached to a memory.

In addition to the web-based interface we offered CLIO via smart personal devices [23]; we developed a custom Android based application and we integrated CLIO with the Layar augmented reality browser. Users of the Android application were offered the combined functionality of both the sharing process, i-recall, and the presentation of collective city memory on a map view, Fig. 4b, and via a word cloud, Fig. 4c. The use of an application compared to that of a browser on smart phones is in general more responsive and can hide to an extend network infrastructure faults. The augmented reality view of CLIO is even more engaging, Fig. 4a; we exploited the off-the-self application Layar, that runs on smart mobile devices, to overlay the memories into the physical surroundings of the user. The memories augment the camera view of the device, as the user points it to his surroundings; he can then select to view any memory in detail. The same application also offers assistance to a user ambling the

city as it can present all nearby memories on a map interface and even display a dynamically calculated route from the user's position to the location of any memory presented on a map.



(a) (b) (c)

Fig. 4. Accessing CLIO via (a) the Layar augmented reality browser, (b) & (c) the CLIO Android application.

5 Methodology: Applying CLIO in the Learning Process

Aiming to study whether the CLIO system may enhance the learning process and enable learning through the collective city memory we invited schools from the city of Corfu, Greece, to apply CLIO in various learning activities. Six schools responded to our call to participate in this study during the years 2010 and 2011; the private high school "Alkinoos", the 1st and 4th lyceum of Corfu, the 2nd high school of Corfu, the high school of Argyrades and the second chance school of Corfu, involving both young students and adult learners. The schools that participated followed our methodology as a school project and carried out a couple of learning scenarios.

The first stage of our methodology focuses on the procedure of collecting personal memories. For this we defined both the space and the time that the collected memories should refer to. Regarding the space, we chose specific areas of interest at the city of Corfu, such as the upper square, Liston, the municipal theatre and the market area. We also set the thematic framework of memories focusing on periodic events, such as processions, Easter, etc., on major events, such as the Second World War, the bombing, etc., and on elements of daily life, such as aspects of the professional and leisure life of older times. Regarding the time, we chose to collect only genuine memories, i.e. narrations of events, which the narrator himself had personally, not stories he had heard; it follows that the recorded memories have a time horizon of less than 80 years.

The collection procedure of personal storytelling was based on the crowdsourcing model [24]. Students were asked to collect personal memories from their family and relatives and they were urged to talk with their parents and grandparents, Fig. 5. To support the interviewing procedure, students could follow the "Interview Guide" we gave them, which included indicative thematic areas and sample questions the student could use to start an interview. We supported both students and teachers who participated in our study with the necessary equipment for the collection of personal memories, like voice recorders and video cameras.

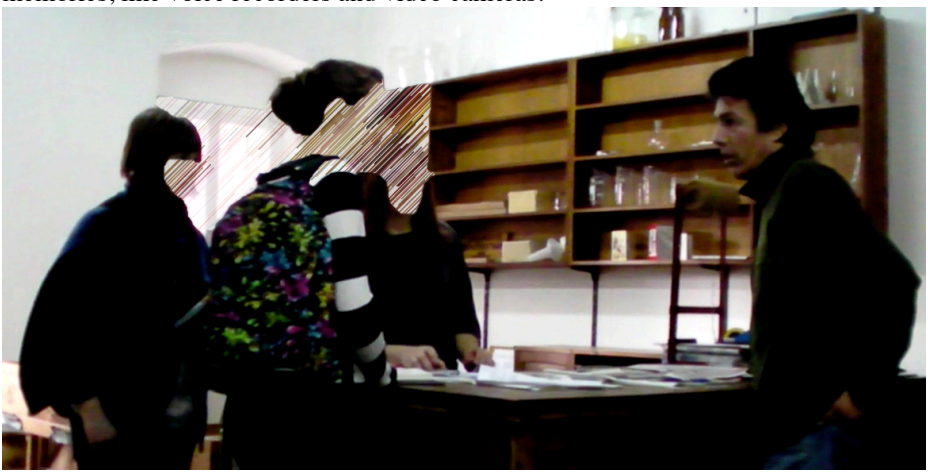


Fig. 5. Students collecting personal memories by recording the interview and keeping notes.

On the second stage of our methodology, students had to edit the personal memories they collected, annotate them and upload them using the i-recall tool of the CLIO system. Students with the help of their teachers edited, if necessary, the text, audio, photo and video files, which they have gathered during the collection procedure. Then students had to identify the spatial, temporal and thematic framework of each personal story. Thus, every memory was annotated with metadata about the person who shared the memory, the place and time it refers to and its thematic area. Students using the i-recall tool located each memory on the city map, defined the time period it was occurred, added a few representative tags about its subject and uploaded all gathered files. Note, that all participants had attended a short course aiming to familiarize them with the i-recall tool.

The main goal of the first two stages of our methodology was the collection of personal memories and the creation of the collective city memory. The third stage aimed to allow students to interact with the collective city memory using the interfaces of the CLIO system. At this stage students had the opportunity to "browse" the collective memory of the city of Corfu, which was created from the collected memories of all the schools that participated in our study. Each school was asked to carry out first a learning activity in the classroom or a computer lab using the web-based interface of CLIO system and then teachers could select to fulfil one outdoor learning scenario like the ones described in section 3. In order to implement these scenarios, students were equipped with smart phones and tablets.

Specifically, the students of the 2nd high school of Corfu were involved in a comparison of commercial and professional areas of the city between the early 60's and today. According to this activity, groups of students walked around the city for about two hours; using their smart phones they viewed selected memories comparing past photos with the present landscape. The students of the 4th lyceum of Corfu wandered around the city following a predefined path aiming to locate and scan 2D QR codes attached to the physical space like buildings, Fig. 6a; scanning the codes they viewed memories about how people celebrated and spent their leisure time in 1960s. The adult learners from the second chance school of Corfu played a treasure hunt game using our interface via the augmented reality browser Layar, Fig. 6b; their objective was to identify radical changes in the city landscape and identify buildings that do not exist, like the installations of the electric company of Corfu in the Old Fortress.

(a)

(b)

Fig. 6. (a) Students scanning QR codes linking the physical space to the collective memory; (b) Adult learner exploring the landscape via the augmented reality browser.

6 Evaluation and Lessons Learned

In our evaluation we exploited both quantitative and qualitative data; quantitative data from questionnaires that students filled in and qualitative data from observations, user trials and interviews. Our aim was to answer research issues in three different areas. The first issue was relevant with the usability of the CLIO system. The second issue was to study whether people can actually learn by interacting with the collective city memory. Finally we studied the benefit of using an urban computing system like CLIO in the learning process.

Aiming to evaluate the usability of our system we asked 12 teachers to fill in a questionnaire after using the Android application; their answers are depicted in Fig. 7. All participants answered that it was easy to use CLIO, Fig. 7a. The evaluation results, Fig.7b, revealed a slight preference to the map view; we attribute this to the fact that users are more familiar using maps. The overall rating of CLIO performance, Fig. 7d, was not as good as expected, as four participants rate it neutral; from interviews we uncovered that this is due to failures and late response of the municipal WiFi network.

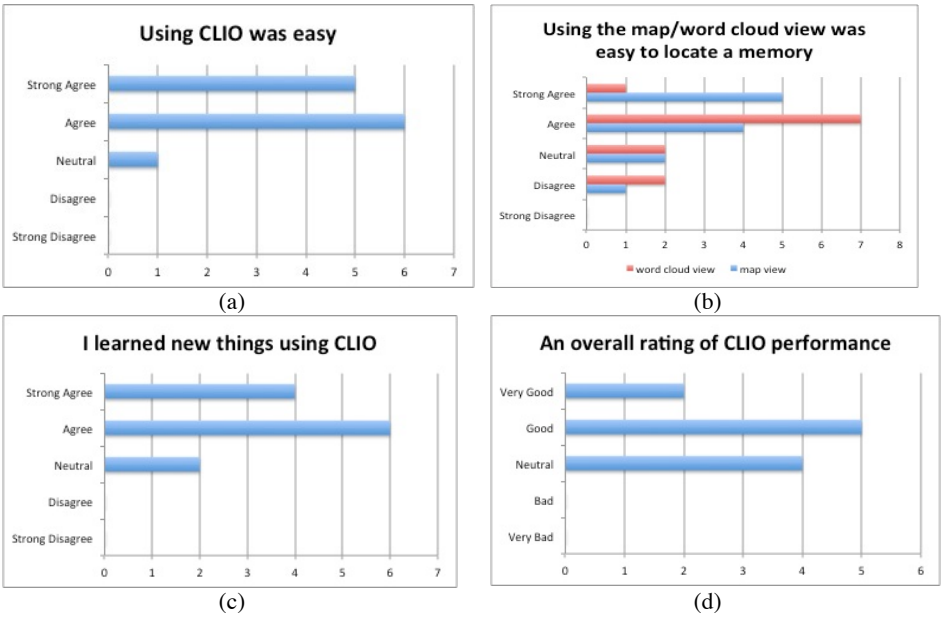


Fig. 7. Evaluation results from the questionnaire regarding CLIO.

Our observations following groups of students using CLIO in carrying out the learning activities and the interviews we conducted afterwards gave us an insight on using CLIO. Regarding the sharing process, the i-recall tool was simple and straightforward to use via the web-based interface; students did not face significant difficulties however most of them reported that it was time consuming. Students were satisfied by exploring the collective city memory of Corfu in the field using smart phones; however the unreliable municipal WiFi network sometimes broke their experience. A student reported: "*I was disappointed to stand in front of the Old Fortress and be unable to view my grandfather's memory about serving his army duty there*". The adult learners that tried out CLIO via the augmented reality browser Layar expressed their enthusiasm with this novel technology and the feeling they acquired viewing the memories attached to the physical space.

Our second research issue aimed to answer the benefit that the collective city memory offers as a learning material. Questionnaire answers reveal, Fig. 7c, that most users learned something new about the city of Corfu while browsing memories. Some comments from the interviews with students that show their excitement of learning follow: "*I did not know that me and my grandfather used to play in the same square*", "*I did not know that the Old Fortress was used as an army camp*", "*I did not know that the bus stop I daily use to go to school is named after a tavern that used to be there*".

In order to assess the benefit of using an urban computing system like CLIO in the learning process we interviewed both students and teachers. Students expressed their excitement about being able to use smart phones in learning activities and taking a class outside their classroom wandering around their home city. It was evident that

students were eager to participate in our study and go out interacting with CLIO. Teachers, also, expressed positive remarks; they found interesting to use novel technologies teaching traditional subjects like local history and encouraging the fact that their students were passionate on carrying out outdoors learning activities.

Conclusions and Future Work

Our experience has shown the benefits of learning in a smart city environment exploiting an urban computing system. Such an environment provides effective and meaningful learning experiences by expanding learning beyond the walls of the classroom, as well as by allowing interaction in the city setting and bringing new interactions back into the classroom [25]. It allows the implementation of attractive forms of learning for children [26] engaging them into an effective and entertaining learning experience. We observed that students were urged to take an active role and work collaboratively [6].

Apart from the aforementioned benefits that improve the learning experience, the exploitation of the CLIO system in learning highlights the benefits of the occurred social interactions. Students seeking to collect memories were engaged in an intergenerational dialogue asking their grandparents to share personal memories; most students enjoyed talking with their families and reported a shared feeling that "*until now I felt that I had nothing in common to talk with my grandparents*". Discussing on the collected memories vivid conversations emerged both in classroom and on the field. Through the process of collecting personal memories, students shared their feelings of participating in a common effort to preserve a part of their city heritage. Interacting with the collective city memory amplified their sense of belonging, as they located memories similar to their owns.

Embracing mobile and ubiquitous learning teachers and students communicate, arrange their activities and change their habits and practices freeing themselves from the confines of the desktop activities [27]. As younger generations are "born" familiar with those systems there is an increasing benefit in adopting such technologies, as they facilitate students to continue their learning process outside classrooms, when and where they desire, through exploration and interaction. Therefore, an increasing interest in physical spaces, in the role of technology in city-wide environments and in passage of learning activities outside the classroom is revealed.

Our future work will focus on how a sociable smart city may enhance the learning experience. With the term sociable smart city we define a city rich in infrastructure, which combines both people and artificial intelligence, empowering and engaging them in activities where urban social interactions thrive aiming to advance the quality of life and culture [28].

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References

1. Weiser M. The computing for the 21st century. Scientific American, 265(3), 94-104. (1991).
2. Weiser M. Some computer science issues in ubiquitous computing. Communications of the ACM, 36(7), 75-84. (1993).
3. O'Malley, C., Vavoula, G., Glew, J.P., Taylor, J., Sharples, M. & Lefrere, P. MOBIlearn WP4 – Guidelines for Learning/Teaching/Tutoring in a Mobile Environment. (2009).
4. Syvänen, A., Beale, R., Sharples, M., Ahonen, M. & Lonsdale, M. Supporting Pervasive Learning Environments: Adaptability and Context Awareness in Mobile Learning, Proc. of the 2005 IEEE International Workshop on Wireless and Mobile Technologies in Education. (2005).
5. Naismith, L., Lonsdale, P. Vavoula, G. & Sharples, M. Literature Review in Mobile Technologies and Learning. Report 11, FutureLab Series. (2004).
6. Kukulska-Hulme, A., Traxler, J. (eds). Mobile Learning: A Handbook for Educators and Trainers, Routledge, London. (2005).
7. Nösekabel, H. Mobile Education: Lessons Learned. Chapter III in the Lytras, M.D. & Naeve, A. (Eds). Ubiquitous and Pervasive Knowledge and Learning Management: Semantics, Social Networking and New Media to Their Full Potential. (2007).
8. Bruce, B. C. Ubiquitous learning, ubiquitous computing, and lived experience. In Cope, W. (Ed.). Ubiquitous learning. Champaign, IL: University of Illinois Press. (2008).
9. Siobhán, Th. Pervasive Scale: A model of pervasive, ubiquitous, and ambient learning. Proc. of the Workshop on Pervasive Learning 2007, Toronto, Ontario, Canada. (2007).
10. Laine, T. H., Joy, M. Survey on Context-Aware Pervasive Learning Environments. Proc. of the mLearn2008, pp. 192-199. (2008).
11. Bouvin, N.O. et al.. Tools of contextualization: extending the classroom to the field. In: Hourcade, J., Rogers, Y. (eds.) IDC 2005, pp. 24–31. ACM (2005).
12. Sharples, M., Taylor, J., Vavoula, G. A. Theory of Learning for the Mobile Age. In R. Andrews and C. Haythornthwaite (eds.) The Sage Handbook of Elearning Research. London: Sage, pp. 221-47. (2007).
13. Rogers, Y., Price, S., Fitzpatrick, G., Fleck, R., Harris, E., Smith, H., Randell, C., Muller, H., O'Malley, O., Stanton, D., Thompson, M., Weal, M. Ambient wood: designing new forms of digital augmentation for learning outdoors. In: Druin, A., Hourcade, P., Kollet, S. (eds.) IDC 2004, pp. 3–10. ACM (2004).
14. Nora P. Between memory and history: Les lieux de memoire. Representations, 26, 7–25. (1989).
15. Halbwachs, M. On collective memory, Chicago University Press, (1992).
16. Huyssen, A. Twilight memories: marking time in a culture of amnesia. New York: Routledge (1995).
17. Boyer, C. M. The city of collective memory. MIT Press. (1994).
18. Crinson, M. (Ed.) Urban memory: history and amnesia in the modern city. London: Routledge. (2005).
19. Postalcy, E., Kuruç Ada, A., Özbek Eren, Y. The new urban memory. Proc. 42nd International Society of City and Regional Planners Congress. (2006).
20. Ringas, D., Christopoulou, E., Stefanidakis, M. CLIO: blending the collective memory with the urban landscape. Proc. of Mobile and Ubiquitous Multimedia 2011, pp.185-194. Beijing, China. (2011).
21. Christopoulou, E., Ringas, D., Stefanidakis, M. Experiences from the Urban Computing Impact on Urban Culture. 16th Panhellenic Conference on Informatics (PCI), pp.56-61. (2012).
22. Christopoulou, E., Ringas, D. CLIO: context supporting collective city memory. Proc. of Multimedia and Ubiquitous Engineering (MUE 2011), pp.6-11. (2011).

23. Ringas, D., Christopoulou, E. Infusing Collective Memory into the City Landscape. The HYBRID CITY II: Subtle rEvolutions Conference (2013).
24. Brabham D. C. Crowdsourcing as a model for problem solving, Convergence: The International Journal of Research Into New Media Technologies, vol. 14(1): 75-90. (2008).
25. Hooft, M.v.t. & Swan, K. Ubiquitous computing in education: invisible technology, visible impact. Lawrence Erlbaum, Mahwah, N.J. (2007).
26. Jones, O., Fleuriot, C., Williams, M. & Wood, L. New Geographies of City Childhood: Wearable Computing Devices and Children's Re-inhabitations of the Urban Environment. Open Space: People Space, An International Conference on Inclusive Outdoor Environments. (2004).
27. Williams, A. and Dourish, P. Imagining the City: The Cultural Dimensions of Urban Computing. Computer 39, 9, IEEE Computer Society Press, 38-43. (2006).
28. Christopoulou E., Ringas, D. Towards the Sociable Smart City. In: Proceedings of the Int. Workshop Sociable Smart City. IOS Press. (2013).