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The Smart City I Would Like. Maps and Storytelling in Teaching Geography

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Abstract

In this paper we present the results of some educational workshops held at selected lower secondary schools within the *Le chiavi della città* (The Keys to the City) project, coordinated by the municipality of Florence. The main objective of these workshops was to motivate students towards an analytical reflection on their city, observed through the guiding principles of the Smart City concept. The students were prompted to discover the new geographies that are modeling contemporary cities and, in order to do this, they were provided with both theoretical and technological tools. The former are necessary for a critical reading of the phenomenon, and the latter to enable them to re-interpret and redesign their city in the light of new findings. The teachers primarily defined the problem domain and presented traditional concepts of scale, place and space identified according to the pillars of the Smart City: Environment, Mobility, Economy, People, Living. Then the students were asked to reshape the urban spaces of their own daily life by using the ArcGIS Online platform. This proved to be a valuable tool because it allowed them to synthesize and to show their newly acquired knowledge. Moreover through the mashup of maps and multimedia contents, they were able to express themselves in a closer way to their common language, and therefore these tools had an important role in the mediation and translation of their ideas into proposals for shared actions.

Keywords: ArcGIS Online, Geography Education, GIS, Secondary School, Smart City, Technology Education

1. Introduction

The project and relevant reflections presented in this article originate from an experience that took place during the 2014-15 school year involving about a dozen schools in Florence, Italy. We started these workshops as part of the project supported by the city of Florence called *Le chiavi della città*[1] (The Keys to the City), an initiative that has been organizing and sponsoring educational projects for pre-school, primary and lower secondary classes for many years. The Laboratory of Applied Geography of the University of Florence, of which the authors of this article are part, was contacted to be included in these

[1] Project website: http://www.chiavidellacitta.it/.

projects to bridge an obvious gap in the overall project scope which was the total absence of activities involving Geography. As a result of this request, several educational laboratory workshops were conceived. These were designed for lower secondary school level students (aged 11 to 14), and they included two meetings of two or three hours each, depending on the availability of each individual class. Although seemingly an easy task, one of the most troublesome obstacles which was encountered during the preliminary phase was the lack of computer labs with a sufficient number of efficient computers with good Internet connection, essential instrumental factors for the success of the educational workshops. The main laboratory planning phase focused on the identification of: 1) topics; 2) the appropriate instruments; 3) the final goals to be attained in terms of knowledge and skills. Consequently, it was decided to direct students towards an analytical reflection on their city, inviting each one of them to, first individually and then collectively, come up with the "Smart City that I would like". The choice of this theme, which was greeted with enthusiasm and led to great student participation, exceeding the teachers' own expectations, is due to the need to combine the classical themes of human geography, such as urban context analysis, with the possibility to directly observe its urban context and the changes it is experiencing and then to identify possible models of development in the light of the most recent studies in this field.

The students were invited to compare the new geographies of contemporary cities using different analysis scales. First of all, teachers circumscribed the problem and presented traditional scaling concepts such as place and space, identifying them according to the pillars of the Smart City: Environment, Mobility, Economy, People, Living (Giffinger et al., 2007). This first stage, in which the teachers had the leading role, introducing new knowledge to the students, and also recalling and stressing already known concepts, was followed by more direct student involvement. They were asked to reshape the urban spaces of their own lives, working in small groups and at first using just blank paper on which to draw their projects and then subsequently transferring these onto a map using the ArcGIS online platform. In other words they were provided with both the theoretical tools necessary for the critical reading of the phenomenon, and the technological tools in order to reinterpret and re-engineer their city in the light of their new knowledge.

We'll see how the ArcGIS online platform proved to be very congenial as it allowed students to represent their new knowledge intuitively, through the combination of maps and multimedia languages which are very close to their usual, daily ways of expression. This was made clear by the high number of participants and by the seriousness with which the students faced the tasks of redesigning their own town or district. This involvement shows how the use of suitable tools close to the students' interests can lead to significant educational results and can be replicated in other contexts.

Furthermore these work groups stimulated the ability to translate ideas, elaborated first individually and then collectively analysed, into proposals for shared actions.

2. Methodology. Different maps tell different stories

The decision to create this laboratory experience having students develop their projects through a story map constructed with ArcGIS Online, was a pretext to stimulate them to reflect on the meaning of the map itself and the link that exists between maps and stories: a map is created to tell a particular story, and it is for this reason that different maps tell different stories. Therefore, each map is not a neutral object, but has in itself a whole set of information which is functionally part of the story that it aims to tell. Maps have always been made to inspire and stimulate people's imagination through their communicative power (Kerski, 2013). After all, if we want to tell a story it is because we have one to tell, a narration that needs to be woven and communicated; a set of contents, made up of characters and events that are interlaced in

certain places, and because of this we can place them on one or more maps.

For further studies on the strong bond that exists between storytelling and maps one can refer to other studies and relative bibliographical notes (Marta and Osso, 2015). For our purpose it will suffice to point out that within our educational project the focus was set on the need for a map to be drawn up with the aim of telling a story, and therefore had to be carefully designed following certain features and specific information, selected on the basis of the story to be communicated.

The students were asked to tell a story entitled *The smart city that I would like*, and to develop it through appropriate multimedia languages that starting from a map could communicate careful problem analysis, accurate information research, study sources and problem solving proposals. A study then, through which a set of knowledge could result in skills, while exploiting specific abilities in the use of appropriate technology.

3. Theoretical approach

The smart city paradigm, although still not univocally defined in literature (Anthopoulos, 2015; Garau et al., 2015, p. 612), certainly encompasses concepts such as knowledge of a place, information availability, technology pervasiveness, mobility efficiency, economic development, energy saving strategies, sustainability, inclusiveness, competitiveness, and in general all the skills required for the achievement of better living conditions and well-being for the citizens who live there.

Taking into account the time available for conducting these workshops (two or three meetings of three hours each per class), the age of the students and their prior knowledge, we were compelled to make a choice and therefore chose to follow the teachings of the Viennese school of Giffinger. According to this theory, a smart city can be read through six dimensions, known as pillars (see below). Therefore, starting from this point, we did not elaborate with the students a critical review of the smart city concept, as can be debated in an academic context, reflecting on contradictions or different positions. The purpose of these workshops was rather to make students more aware of what might be urban development trajectories, according to the proposed model, to which they could themselves participate as active citizens, in a scenario where they are constantly surrounded by actions and objects labelled as “smart”.

In order to relate the proposed theme to the actual experience of the students, we attempted to analyse the concept of smart city in a more strictly Italian scenario, in which urban development in this direction is not homogeneous (Forum PA, 2016) and especially where the urban distribution is made up of small and medium-sized towns, with limited population and size compared to the major international examples on which the paradigm was modelled and therefore the project should be considered in light of this different context (IFEL, 2015). As a result, the questions that students were initially asked were:

1. In light of the reflections we have shared, what smartness conditions con you propose for your town?

2. What do you consider already smart in the urban space that you live in? (Neighborhood or extended city depending on the different situations).

3. What every day experiences of interaction with the spaces and people do you think could make your city smarter and provide a better life style?

On the base of Peter Haggett’s classification notes on the characteristics of geographical surveys, we chose an “ecological” approach of analysis, focusing on the importance of the interaction which develops between the environment and the people who live there and on how this moulds the environment in which they settle (Haggett, 1993, p. 11). It was important to have the students understand the general impact of community actions upon a territory, and upon their personal civic role in participating in the definition and the improvement of their own cities, in particular. These reflections were contextualized within that dimension that some years ago entered the

common geospatial revolution[2] language, the expression with which we refer to the increased availability of spatial satellite data and the increasingly powerful technologies that interpret, reshape and make this information accessible on various platforms, both on the web and on mobile devices.

It was important to have the students understand that everything happens in a determined place and that the analysis of the phenomena starting from its spatial dimension leads to deeper understanding.

Learning to think spatially, meaning also the ability to tell stories starting from a spatial dimension, must be considered a primary proficiency alongside reading literacy, mathematical literacy and scientific literacy (Zwartjes, 2014), which are already valued on an international level[3], since this is becoming more and more part of our everyday lives[4].

In our specific case, the proposal to analyse the Smart city concept and to represent variations in specific contexts was the driving force behind honing spatial literacy in the students, as a set of abilities connected to thought and to spatial action. That is to say, the aim was to communicate in the form of a map, understand the symbolic components of a map, recognize and interpret patterns, comprehend basic concepts as scales and spatial resolution (Goodchild, 2006). We are convinced that the understanding and the proper use of geographic information is a skill which students can benefit from later in complex decision-making contexts which are not necessarily connected to geography.

On a European level, the digital-earth.eu network, which studies the use of geographic media in schools and in teacher training, connecting them to the innovative European centres in this field[5], has recognized the importance of the introduction of geo-media, and in particular of GIS, in education for the development of three areas of competence: personal, social and professional (Zwartjes, 2014). We therefore tried to stimulate each student towards a geographical approach to problems, in order to address them critically and constructively and, at the same time, making it clear that only if well-equipped with knowledge and solid skills can each citizen play an active role and effectively participate in society. It goes without saying that the adoption of constructive, active learning practices, using problem solving and project-based methods will prove helpful to students in future professional challenges. We therefore adopted this educational model in order to have the students and teachers involved in these laboratories understand that geographic knowledge is something that goes beyond the rote learning of place names.

[2] See the famous four episodes carried out by PennState University also published in the National Geographic magazine (http://geospatialrevolution.psu.edu/; http://education.nationalgeographic.org/media/geospatial-revolution/).

[3] See the periodic survey report by the Programme for International Student Assessment – PISA made by OECD (https://www.oecd.org/pisa/). Italian site: https://www.oecd.org/pisa/keyfindings/PISA-2012-results-italy-ITA.pdf.

[4] According to the standards formulated by the American National Research Council, spatially literate students have the following characteristics: "1. They have the habit of mind of thinking spatially—they know where, when, how, and why to think spatially. 2. They practice spatial thinking in an informed way—they have a broad and deep knowledge of spatial concepts and spatial representations, a command over spatial reasoning using a variety of spatial ways of thinking and acting, and well-developed spatial capabilities for using supporting tools and technologies. 3. They adopt a critical stance to spatial thinking—they can evaluate the quality of spatial data based on its source and its likely accuracy and reliability; can use spatial data to construct, articulate, and defend a line of reasoning or point of view in solving problems and answering questions; and can evaluate the validity of arguments based on spatial information" (Down et al., 2006, p. 4 ss.).

[5] "digital-earth.eu network project is a Comenius Multilateral Network (2010-2013). It complements the activities of two previous Comenius Multilateral Projects (GISAS and iGuess) that used specific GIS software and produced teaching materials for schools and training courses for teachers" (http://www.openeducationeuropa.eu/en/project/digital-eartheu).

Drawing from the skill sets outlined by Zwartjes (Zwartjes, 2014, p. 54 ss.) we focused on some of these in the creation of our specific activities:

- "Pedagogic and didactical skills for the use of digital earth tools in school" and "Ability to use digital earth tools (also technological skills)": i.e. the ability to read a GIS interface recognizing its main tools and planning all possible actions so as to set up one's own working environment, to be able to choose the basic map and to define suitable bounding boxes for the purposes of the implemented map (Goodchild, 2011);
- "Understanding complex and changing interrelationships": the students were presented with a forecasting scenario stating that by 2050 the world population would reach 7 billion inhabitants, of which at least 2/3 of them would be concentrated in the cities, in an inverted trend from what happened a century earlier (United Nations, 2014). In this scenario, they were asked to reflect on the consequent problems associated with the following variables: Environment (resource management and waste disposal), Mobility (transport networks and alternative mobility), Economy, People, Living and Governance (how to contain social problems connected to population density and how to contribute to people's welfare). These variables were first individually analysed and then seen as part of a complex system of relationships;
- "Ability to use spatial skills in real world problem-solving contexts": the global scenario presented from a theoretical point of view was represented on an urban scale in known contexts in order to solve a specific problem: how to develop this smartness idea within our neighbourhood or even in the whole city where we live, starting with the identification of antithetical situations and focusing on where to intervene.
- "Lifelong learning competencies: ability to find training opportunities, time management, planning competency, communication competencies" and "Social learning: being able to work with others – teamwork": even though our time was limited, the students, who were divided into groups, worked as project teams, attributing roles and analysing together proposals and solutions;
- "Being able to identify and evaluate resources": part of the data produced by the students was a result of processing contents found on the web, which they had to evaluate in advance, by themselves or with the help of their teachers.
- "Access information efficiently and effecttively, evaluate information critically and competently (see maps as manipulated representations created by people/organizations with a certain purpose, e.g. classification methods, colour schemes, map contents)";
- "Manipulate maps: Display information on maps; Create own maps; Communicate cartographic information": the final result of the re-planning of their home city in a smart key reading, was entrusted to a map on which information was superimposed which was essential to the project communication;
- "Understand the construction of digital maps as a representation of the real world: The power of maps (reliability of data, classification and colour schemes)": the resulting maps, although very simple, were functional in raising the students' awareness of the communicative power of a map, not only as a means of description but also as a means of prediction;
- "Use digital earth tools for investigation/research: Interpret content; Identify and ask significant questions that clarify various points of view and lead to sustainable solutions; Frame, analyse and synthesize information in order to solve problems and answer questions": the achievement of this competence was without doubt one of the key points of this project. The students thoroughly discussed the sustainability of their proposals and, only after the adopted solution seemed appropriate to solving the problem, they worked to find its correct representation using the working environment in an exploratory manner and discovering, for example, that their city took on new meaning and values if viewed on a satellite image or on a topographic basemap.

3.1 Participants

In total, the project involved about a dozen classes with an average of 25 students each, belonging to seven middle schools, all in the area of Florence. The students' ages ranged between eleven and fourteen.

According to Italian school laws, the teaching of geography in middle schools is entrusted to the Italian teacher and the combined use of technology is left to their free initiative. We must note that due to the lack of teaching time, computerized equipment in the classrooms, and teachers' expertise, the use of technology while teaching geography and especially GIS is extremely limited. Regarding the latter we are not aware of any significant experiences in middle schools.

Each workshop involved the geography teachers and two experts from the University.

3.2 Tools

When we examined which tools we needed to provide for a practical transformation of the theoretical aspects, the answer was sought in instruments that were able to integrate objects closest to the common understanding of a story or narration. Starting from this idea we chose multimedia texts, images and video, and an intuitive and easily understandable GIS with an interface that could be used by students with little or no prior knowledge of it. Currently, geographic information systems technologies are used daily by a growing number of users at various levels of complexity ranging from simple service localization or route calculation, all the way up to integration into decision support tools and spatial analysis. However, there is very little, when any, use of GIS platforms in teaching contexts, even when functional to learning geography (Yap et al., 2008) despite the potential that these have and the growing need to integrate technology to learn not only how to use technology per se, but also the acquisition of disciplinary knowledge and skills through the use of technology. In fact, GIS are not a goal in itself but a means to using spatial thinking skills, as they constitute both a support for geography teaching and learning, and a tool to study geographical problems at a large number of levels as well as being an essential tool for knowledge workers in the twenty-first century (Bednarz, 2004; Zwartjes, 2014).

In particular, GIS provide technology that stimulate the development of synthetic-analytical and methodological-application capabilities through geographical research, enabling the production of communicative and effective cartographic processing, which can be interpreted by merging a wide range of expertise contained in geographical knowledge (Pesaresi 2011, p. 135). Moreover, as seen in these classrooms, the opportunity to engage students in active and collaborative learning, also based on the use of extremely up-to-date computer-geographic instruments, was key to the project's success. According to some authors (cfr. Liu and Zhu, 2008), this comes about when geographical research is connected with constructivism, especially where learning through problem solving and research-based studies prevails over a learning process based merely on content sequences. A GIS environment is, then, a computer-based training ground for constructivist-learning of geographical knowledge. Generally speaking, school education has gradually shifted to a constructivist model in which inquiry-based and problem solving learning is emphasized, and in this direction geography studies can also find an entirely appropriate theoretical collocation. In fact, following this model, we acted as guide teachers responsible for resource organization and problem location for students, who were entrusted with the responsibility of formulating research objectives, collecting and analysing data and information, and finally sharing their findings with the other students. In this way, the students themselves conducted the knowledge creation process through assimilation, by incorporating new experiences, and accommodation, by modifying and adapting existing cognitive structures in response to their own personal environment. In a social constructivism dimension (Gasper, 1999) students' abilities unfold with the solution of real problems, as in our case where they had to identify non-smart situations in their cities and then re-design them, and consequently build new

knowledge through social interaction processes, represented here by small groups of students, who first interacted within the group and then shared their findings with the other groups.

The online ArcGIS platform, which was chosen as the tool to develop and communicate solutions to the proposed problem, represented a completely suitable work environment for the constructivist model, where the students had the opportunity to negotiate and reflect on their ideas, develop research and communicate their results, thus giving efficacy to the whole learning process. Through this platform it was possible to activate a learning environment capable of providing multiple representations of the world, enabling collaborative knowledge construction, integrating different sources of information and different means of expression, adaptable to different needs and different student intelligences. In this regard, Goodchild (2009), referring to Gardner's classification of multiple intelligences (1983), alongside verbal and logical-mathematical intelligences, adds the visual-spatial that involves manoeuvring skills in the physical world and, at the same time, the use of mental representations and models that allow us to interpret meanings in images and on maps. To stimulate a similar type of intelligence, tools and technologies facilitating this are becoming more and more important.

4. Results

The first result which we would like to point out is the students' positive reaction to the proposals and suggestions tangible in the seriousness with which they took on the task-assignment of identifying and solving a problem in their own urban context. We can also say, on the basis of the teachers' statements, that even those students who were usually unwilling or reluctant to participate in class activities were actively involved in the program without much difficulty and actually demonstrated proactive attitudes.

All the students discussed in groups the functional and perceptive characteristics of the city in which they live, reasoning first on an urban scale, and then on a neighbourhood based one. They debated on the, new for them, Smart city concept, in particular on the aspects of mobility, energy conservation, quality of life and relationship spaces, issues that boosted their keen interest.

Another interesting aspect is that in the online ArcGIS platform they discovered an environment through which they could tell their new geography through a story, or better to rethink their daily lives through a mappable space. They managed to build and shape, even if only on a virtual scale, the space they inhabit, showing designing skills, inspired by a civic sense of duty, and then they shared it with their class. Figures 1 to 4 are just a few of the screenshots taken from the Webmapping applications they created. Generally, the first action was to identify critical areas in which to place urban recovery interventions. Then students searched the web for images, video or data on similar situations, so as to produce more or less complex mashups of text-audio-video contents. These proved to be very effective and immediate communicative expressions being so close to their language.

The final product of their work consisted of Webmapping applications, very simple in some cases, in others more elaborated. In these, each group combined the maps made by themselves, containing their personal project records, web links, images and videos found in internet, consistent with the object and the aims of the project.

Interestingly, some groups emphasized that smart does not necessarily mean having more connectivity, but in general to having areas in which to meet and play freely, such as for ball games, or even just green areas perceived as places to assemble. By contrast, others focused their projects on an enhanced WiFi network, particularly along the route from home to school.

Some, starting from the observation of their own neighbourhoods, designed a network for rainwater collection to be reused in the maintenance of flower beds or roundabouts or traffic islands so that these would be more beautiful and the city less gloomy.

Others felt the need to have public school transport organized in such a way as to shorten the time travelling between home and school, and consequently they laid out routes,

consisting of nodes and segments, and more suitable means of transportation.

They all focused on the need to be able to get to their daily life places (school, leisure centres, gyms, etc.) in a safe way, excluding the need for an accompanying adult. They perceived as an improved quality the possibility of living and experiencing individually a place, which would not be hostile or perceived as unsafe.

In general, their considerations started from an analysis of their everyday lives, and only in a subsequent step did they widen their projects to a larger scale, extending their actions to the entire neighborhood or the city.

Van Leeuwen and Scholten (2009) point out how when teaching it is also important to convey a "sense of fun". Generally speaking people learn more easily when they are having fun in what they are doing. In our experience we noticed how while using GIS and integrating maps, data, and multimedia content in an easy-to-use tool, students did not feel any burden of completing their assigned task. Indeed many perceived it as a game, with its share of fun. Furthermore, this environment greatly benefits from being a non-linear medium, in which you can / you must enable links, as is typical in any Web environment, combining the linearity of traditional storytelling with the networking of a hypermedia hypertext. From a constructivist point of view it helps students to reflect on the knowledge creation process they are producing.

We observed students as they progressed in their geographic research, raising questions and formulating hypotheses, wondering where and if it were possible to find data to support the latter. The phase in which they showed the greatest enthusiasm was when presenting and communicating their projects, carefully choosing the cartographic bases and thinking about the symbols to be adopted and looking for publicly available information.

In general, the real relevance of the theme and its social and cultural impact stimulated reflection, but without doubt the technology chosen was crucial for the students' active involvement, while also helping teachers to monitor the learning process through interaction with the students and stimulating critical thinking about the content and usage of online resources (Liu and Zhu, 2008).

5. Conclusions

The Laboratory of Applied Geography designed and set up several educational workshops designed for lower secondary school classes, to experiment geography learning methodology using an inquiry-based constructivist approach which started from a general theoretical position on a global scale, proposed by the teachers, and then applied by the students on a local scale through a problem solving approach. The chosen theme connected to the smart city concept was presented by the students through web story maps built using ArcGIS Online, a platform that, for almost all the students, represented their first contact with a GIS environment. The results of the experiment were assuredly very positive, except for some difficulties due to the inefficiency of some school computers and internet connections.

Despite not having any previous GIS knowledge and technological competence, after a brief introduction to the technology, the students showed lively interest in discovering its potential. They immediately understood how to use it to achieve their set tasks, that is to say the analysis of some problems of their cities, concerned with sustainable mobility, energy conservation and waste recycling, as well as with relationship spaces for its inhabitants, Internet connectivity and the management of sensors and intelligent applications.

Students took their task of designing new urban areas in a smart way seriously and were interested in finding ways to tell their stories through maps conceived by themselves.

The geography lesson was thus an excuse to experiment new visual languages and become familiar with geographic technologies too often and for various reasons, left aside when teaching geography. The students were able to learn and, at the same time, to impart their knowledge through a GIS platform, which proved to be instrumental in the acquisition of new knowledge and new skills, and was a stimulus for an in-depth analysis of more complex environments.

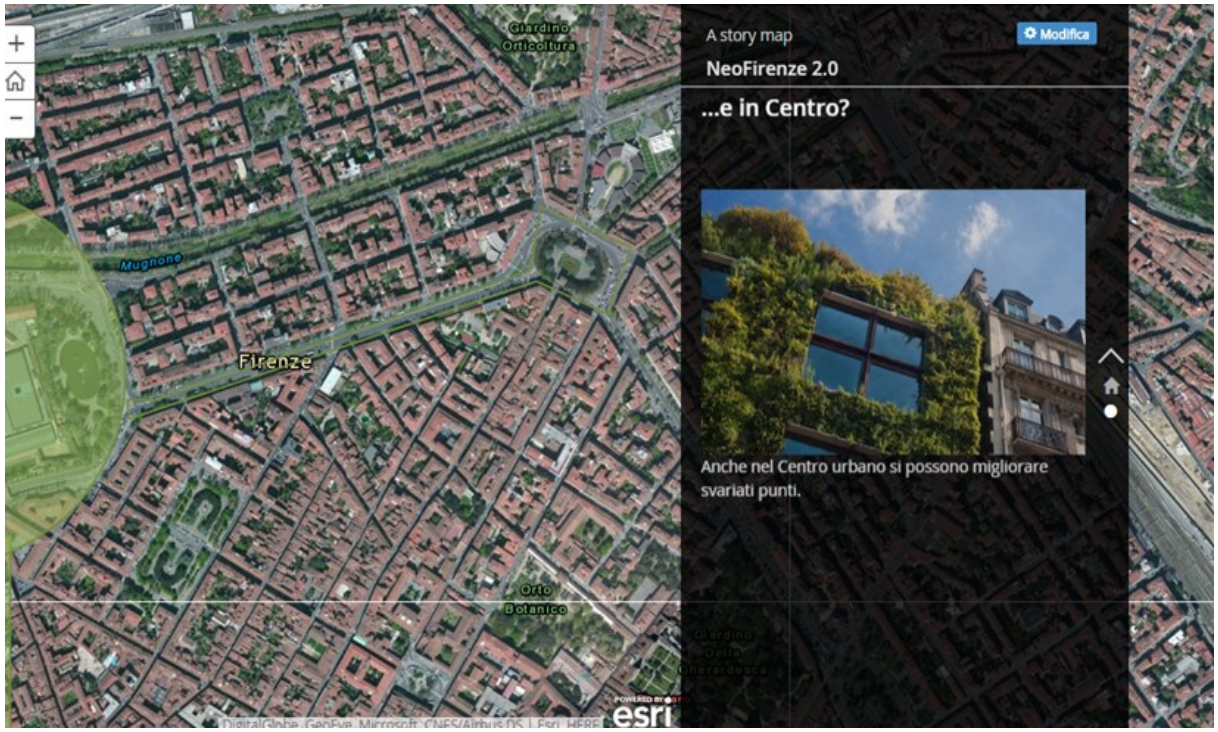

Figure 1. Some of the neighbourhood areas identified as critical.
Source: Original student elaboration.

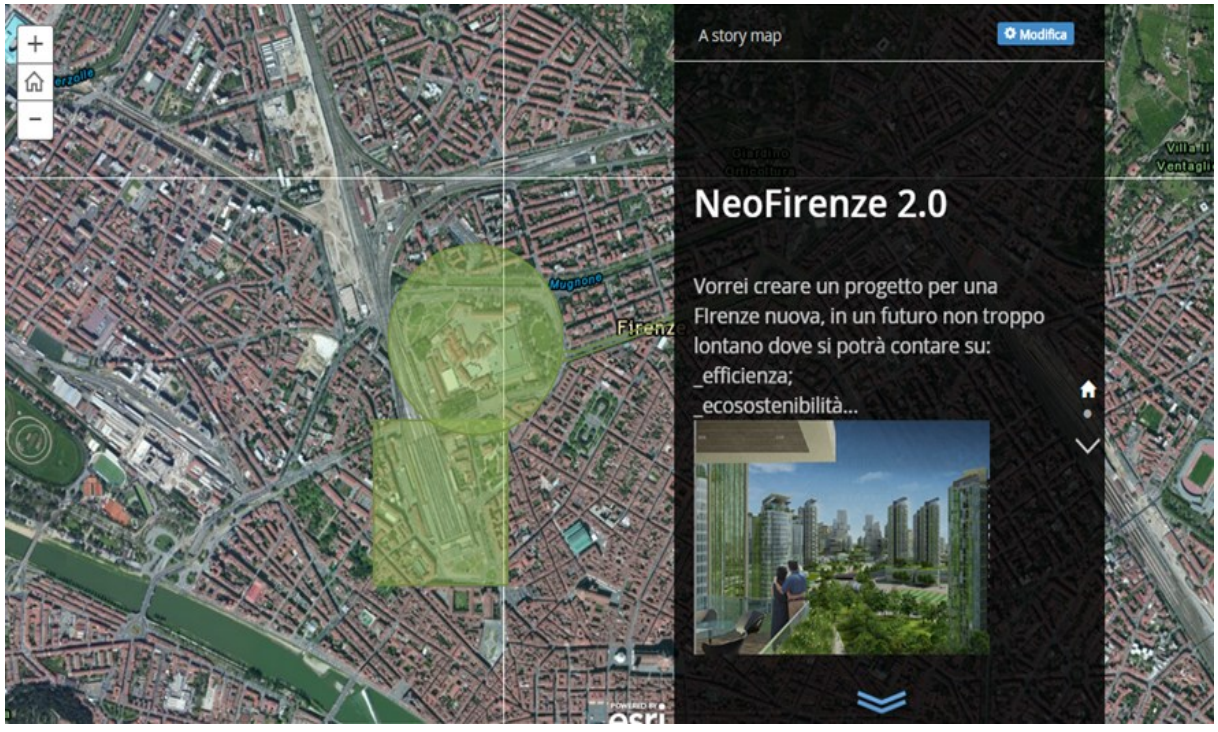

Figure 2. Some of the neighbourhood areas identified as critical.
Source: Original student elaboration.

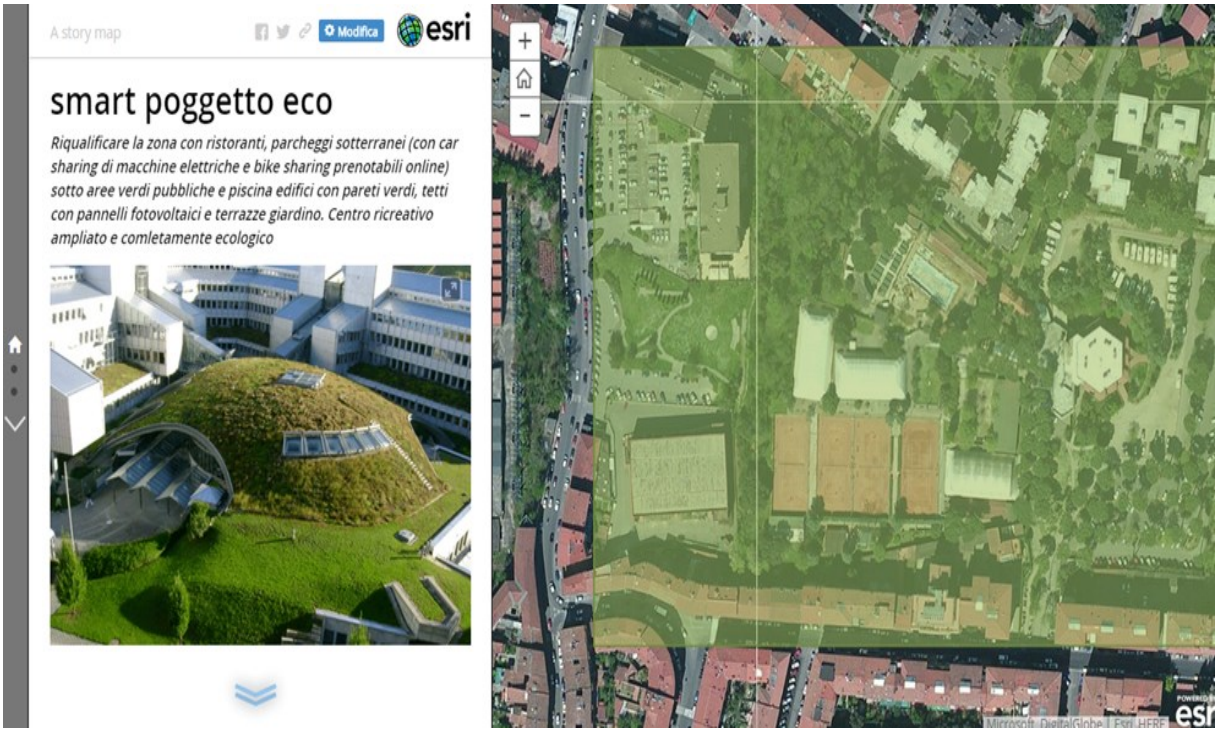

Figure 3. Proposed neighbourhood redevelopment.
Source: Original student elaboration.

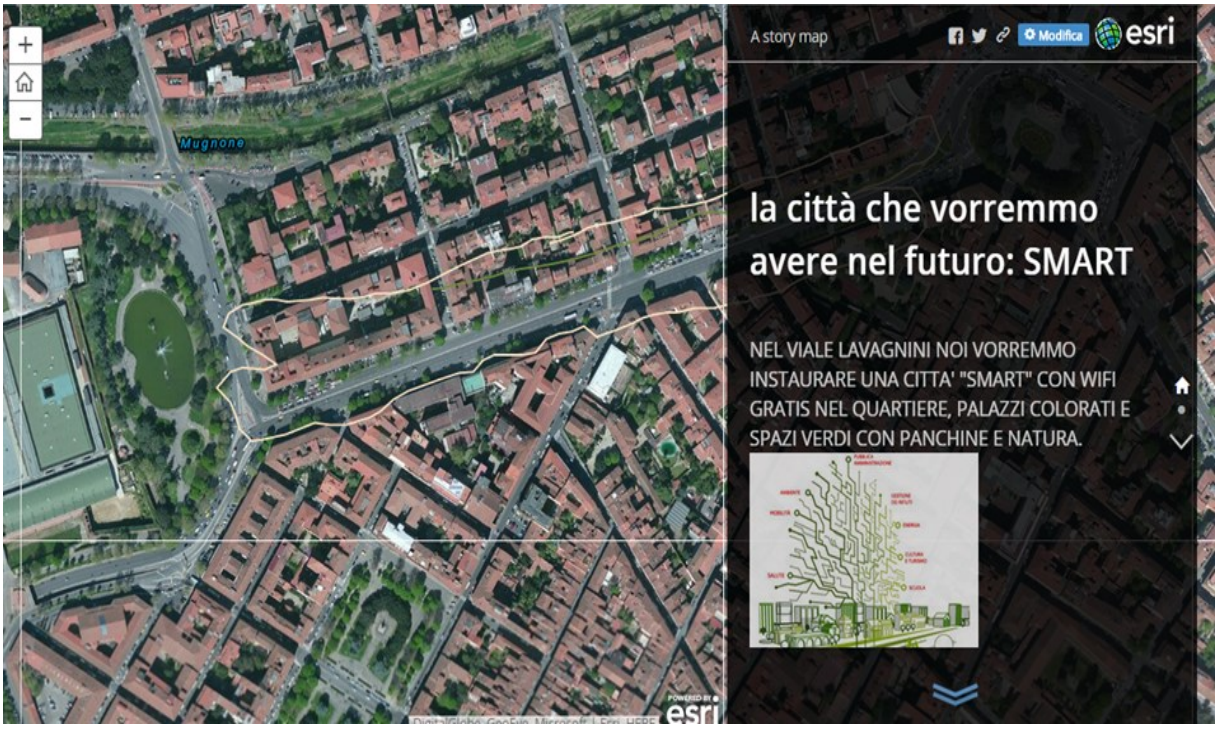

Figure 4. Intervention identification. Once again the choice fell on areas close to the school.
Source: Original student elaboration.

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