En Plein Air: 
A Mobile Learning Approach for Sustainability Education in the Wild

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ABSTRACT

This paper discusses educational challenges and design opportunities concerning the use of mobile technologies in the context of education on sustainable development. The discussion will be supported by the presentation of a pedagogical model and a technological platform consisting of Web and mobile technologies designed to support a mix of formal and informal, indoor and outdoor learning experiences. In particular, the platform is a reconfigurable system that can be adapted to support different kinds of learning formats. The paper presents two use cases and the authors discuss the implications of mobile technologies in the field of education for sustainable development, taking into consideration both pedagogical and technological issues.

Keywords: Education for Sustainable Development, En Plein Air, Mobile Learning, Place and Project-Based Learning Approach, Wild

1. INTRODUCTION

Education for sustainability (ESD) is characterized by an interdisciplinary approach, with the unifying theme being a study of the relationship between society, economy and the environment. ESD should be built on value-based learning, which promotes system thinking and emphasizes creativity, innovation, and our responsibility toward future generations.

In a recent paper, published in the Journal of Sustainability Education, Burgess and Johannessen (2010) challenge the current ESD practices in many respects. By reviewing several studies, the authors highlight a trend: “we have watched sustainability education grow and define itself in contrast to place-based, nature-centered, experiential environmental education and see this as a detriment to the emerging discipline’s ability to accomplish its stated goals”. According to their perspective, ESD has been more focused on abstract and theoretical learning on economic and social issues, without building an underlying curricular foundation based around experiencing
the natural world. They believe that to pursue ecosystem-based resource management, to understand functional ecosystem processes, or to gain an systemic understanding of sustainability requires “the cultivation of intimate knowledge of one’s home ground, of paying close attention to one’s surroundings and exploring one’s values and feelings based on the relationship of people to nature.” Ultimately, they argue that “to inspire people enough to make changes in their perceptions and behaviors, sustainability education must embrace the central role of acquiring ecological knowledge through direct and shared experience in the natural world.”

In attempting to achieve effective long-term behavioral and attitudes changes and to promote responsible choices, more traditional and formal education systems are lacking. In this paper we focus on experiential education in order to address the complex challenge of education for sustainable development. We intend to promote a vision in which based the development of systemic and critical thinking, envisioning and creativity skills, and the ability of assessing personal values with respect to social and cultural context is grounded in place and project based, nature-centered learning activities.

In line with the situated cognition perspective (Brown, Colling, & Duguid 1989), we believe that direct experiences in the natural and the social world are the basis from which the ability to consider broader connections and imagine alternative futures can unfold. From immersive learning experiences in natural settings, learners can cultivate deeper understanding of sustainability issues by anchoring their own personal observations and values within a broader social, cultural and economical context.

By providing new means of interaction and participation, mobile and Web technology offer the opportunity to make new ways of learning possible. The use of integrated mobile and Web applications can offer exciting new possibilities to promote the changes in education methodologies called for in ESD.

Mobile devices enable ubiquitous access to information and media content while enabling the creation of new tools for learning and productivity. Devices themselves continue to evolve as their increased access to affordable and reliable networks makes them a user’s first choice for Internet access (Johnson et al., 2011). In addition, the number of mobile devices produced and purchased each year continues to grow, and newer devices and device formats continue to alter our notions of portability.

However, as the growing significance of mobile learning in higher education demonstrates (Traxler, 2007), the application of mobile devices to traditional practices within the formal educational system will not be sufficient to achieve educational objectives. It is of fundamental importance to develop relevant and innovative pedagogical practices and assessment methods for diverse, non-linear learning pathways by providing a mix of formal and informal learning opportunities. Such developments would lead towards the future of mobile learning. So far, the recent growth of the domain has been built on short-term, small-scale pilots and trials in the developed countries of Europe, North America, and the Pacific Rim. Mobile learning is considered relatively immature in terms of both its technologies and its pedagogies (Traxler, 2007).

The main objective of this paper is to discuss the main challenges ESD brings in order to extend formal school pedagogical practices and motivating everyday informal learning, and explore a set of pedagogical formats for mobile learning that can address the identified challenges. According to Paas (2008), ICTs could play an important role in advancing ESD practices in two ways: by increasing access to educational materials about sustainability and by helping to promote new ways of interacting in order to facilitate the learning called for in ESD that emphasizes not just knowledge, but choices, values and actions. With respect to the second aspect, Mobile technologies offer a new interesting opportunity. By presenting
two different use cases based on the Locast technological platform (Brunnberg, 2011), we aim to promote a vision where the design of the technological environment is deeply grounded on a specific theoretical approach to education around sustainability as well as to raise a discussion on the potential of mobile technologies for experiential education for sustainability.

The Locast platform, developed by the Mobile Experience Lab at MIT (http://locast.mit.edu), combines Web and mobile applications to facilitate the creation of location-based learning experiences. The mobile application enables the user to create geo-located media content, either in individual fragments, or together with peers in larger-scale reportages on a specific topic. The application provides possibilities for enabling immersive learning experiences while discovering sustainable development in the wild. Media content is created and shared in real-time on the platform website where the entire members’ community can join the conversation.

According to the framework of mobile learning identified by Kukulska-Hulme and Traxler (2007), the Locast software platform puts in place technological and pedagogical innovation by enacting an informal, personalised, and situated mobile learning approach to ESD. We named this approach “En Plein Air.” Locast educational experiences rely on functionalities, like location-awareness or video-capture, able to support collaborative field activities. Utilizing Web and mobile interfaces, the Locast platform connects learning experiences in the wild to classroom activities.

The paper is therefore articulated in the following sections: in Section 2, we will present the relevant literature regarding mobile learning in order to identify an appropriate approach for ESD. In Section 3, we will introduce the En Plein Air learning approach and how it is enacted by the Locast software platform. Then, in Section 4, we describe two use cases that show how the En Plein Air approach and the Locast software platform have been used. Finally, in Section 5, we discuss a set of assets that mobile learning in the field of ESD should address to be effective.

2. MOBILE LEARNING AND THEORIES: STATE OF THE ART

In recent years, Mobile learning has drawn on the theory and practice of pedagogies used in Technology Enhanced Learning and others used in traditional classroom learning. It has taken place as mobile devices are transforming notions of space, community, and discourse (Katz & Aakhus, 2002; Brown & Green, 2001). There is currently a need for pedagogical models that are appropriate for Mobile Learning, and that allow researchers to investigate and tackle the challenges each specific application domain poses, i.e., the Education for Sustainable Development.

In this review we assume an activity-centered perspective, considering new practices against theoretical approaches, following other experts in this domain (Naismith et al., 2006).

In this section we consider the kinds of activities that can be enabled through the use of mobile devices under the categorization of relevant theoretical approaches from the study of learning and, in particular, learning with technology. As anticipated in the previous paragraphs, the investigation of ESD domain led us to focus on studies that regard:

- Constructivist learning–activities in which learners actively construct new ideas or concepts based on both their previous and current knowledge.
- Situated learning–activities that promote learning within an authentic context and culture.
- Collaborative learning–activities that promote learning through social interaction and participation.

These approaches are intended to provide a loose theoretical background for reviewing the case studies presented.

Either constructivist and constructionist (Papert, 1980) experiences or named participatory simulations (Naismith et al., 2006) may be ascribed under the Constructivist approach to mLearning. This approach is comprised of learn-
ers actively constructing their own knowledge and learning by building interactive models and participating in simulations. Mobile devices provide learners with the unique opportunity to be embedded within a real world context at the same time as having access to supporting tools. The Savannah study (Facer et al., 2005) explored the use of mobile devices to enable a rich, interactive learning experience about lions. Students in Savannah got to play the role of lions roaming in the wild in an area 100m x 50m. Each student carried a PDA that gave them a window into the game world, displaying content and actions that were appropriate to their current location and what was going on in the rest of the game. Each PDA could be tracked using GPS, and allowed the students to ‘see’, ‘hear’, and ‘smell’ the virtual savannah they were exploring. This study highlighted the changing role of teachers and facilitators in the mobile learning experience; the importance for students to occupy multiple roles the role of expectations through the game-based learning (Facer et al., 2005).

A second constructivist exemplar study is the MIT Environmental Detectives project (Klopfer & Squire, 2008) where context-sensitive data and social interactions are used to supplement real world interactions. The goal of the Environmental Detectives game was to teach secondary school and first year undergraduate students the skills of environmental inquiry, using a simulated environmental problem. A multiplexed scenario was built around a spill of a toxin called Tri-Chloro-Ethelene, which is a ground water contaminant with moderate long-term health effects. The game included functionality to support the collection of both primary data (raw data on contamination levels acquired by sampling) and secondary data (interviews with ‘virtual’ experts). The game was location-based, with the ‘virtual’ activities only being available in certain ‘physical’ locations, as detected by a GPS module attached to the Pocket PC. The interface was primarily map-based, and students worked in pairs to navigate through the physical space to get to the virtual information (Klopfer, Squire, & Jenkins, 2002). The goal of the game was to discover the source of the contamination and prepare a suitable remediation plan.

The Situated approach to mLearning emphasises the idea of cognitive apprenticeship, where teachers work alongside students to create situations where the students can begin to work on problems even before they fully understand them (Brown et al., 1989). Situated learning requires knowledge to be presented in authentic contexts and learners to participate within a community of practice (Wenger, 1998; Naismith et al., 2006). Exemplar Situated learning experiences are both Problem-based learning (PBL) activities (Koschmann et al., 1996) and Case-based learning (CBL) (Kolodner & Guzdial, 2000). The Ambient Wood study (Rogers et al., 2002), part of the EPSRC-supported Equator project is an exemplar research focusing on the integration of physical and digital interaction. The experience was designed for 10-12 year-olds. A series of activities were designed around the topic of habitats, focusing on the plants and animals living in the woodland environment and the relationships between them. An open clearing and a wooded area were chosen as they have different distributions of organisms and interdependencies among them.

The learning experience was characterized by three stages:

Stage 1: Exploring and discovering. Pairs of children equipped with a PDA explored the two habitats. In addition to what was observable around them, they could find out additional information about growing processes, feeding behaviours and organism dependencies. The PDA provided information either in response to probe readings on moisture and light at a specific location, or triggered by the children’s physical presence in a certain location in the habitat, using a combination of pinging and GPS location tracking.

Stage 2: Reflecting, consolidating, and hypothesising. After exploration, the children gathered in a den with a classroom-like setup, where they could use an interactive
display to share their readings from the exploration and collaboratively reflect on their findings and experiences.

Stage 3: Hypothesising and experimenting. The children were sent back into the wood to observe experiments where either new organisms, or changing moisture and light levels, were introduced into the habitat.

A second example focusing on discovering nature is represented by the Natural science learning in Taiwan (Chen et al., 2004). A butterfly-watching system was implemented and tested at an elementary school in Taiwan. The objective was for the students to learn about natural sciences, and more specifically about the different kinds of butterflies in the region. The project was based on the premises of independent learning, with the assumption being that providing appropriate mobile tools would help students to become capable, self-reliant, self-motivated and independent. A database of different butterfly species in Taiwan was used with a content-based image retrieval system, and an online nature journal system. The students visited a butterfly farm, where the networking environment was set up and they could use their PDA cameras to take photographs of the butterflies they observed. By matching with the photos in the database, the students could decide which match was best, and the database would verify based on image content similarity.

The Collaborative approach relies on the capability of mobile devices to support active participation by the users. Hand-held devices naturally foster dialogue, exchange and collaboration in small groups or large public arena. Cultural heritage organizations and museums are also turning to mobiles to educate and connect with audiences (Johnson et al., 2011). The Museum of Science in Boston, for example, collaborating with researchers from Tufts University, has created Firefly Watch, a mobile application for visitors and native Bostonians that allows them to serve as local “citizen scientists” to aid real scientists in a large regional study of firefly populations. Artists and performers are experimenting with mobile devices to increase audience participation and expressivity. As exemplar case, at the performance of Othello at Abilene Christian University, attendees were asked not to turn their phones off during the performance, but instead to use them to receive messages throughout the performance (Johnson et al., 2011). Cast members behind the scenes sent messages to clarify Shakespearean language, share scene summaries, and interact with the audience through a live blog.

3. THE EN PLEIN AIR PEDAGOGICAL APPROACH TO EDUCATION FOR SUSTAINABILITY

3.1. Challenges in Education for Sustainable Development

The current practice in ESD tries to build interdisciplinary and value-based curricula to promote the acquisition of different transversal capacities such as critical and systemic thinking, to foster responsible behaviors and to effect long-term attitude changes toward environment and society.

An instructional approach, seeing knowledge as something that should be instructed and existing in a world independent from the experience of the learner, is not well suited for ESD since it doesn’t enable learners to connect their actions with the impact they have on the planet (Huckle & Sterling, 1996).

Beyond the acquisition of formal knowledge, the promotion of dialogues, negotiation and inter-personal skills are considered to be fundamental aspects of ESD curricula (Tilbury & Wortman, 2002): the maturation of a personal point of view and the ability to relate scientific knowledge to systems of personal and social values lay at the core of decision-making processes and responsible behavioural choices.

Different from traditional practice of Environmental Education, which focuses on teaching and learning, in and ‘for’ the environment, education for sustainability seeks a transformative role for education, in which people are engaged in a new way of seeing, thinking,
learning and working. People are not only able to explore the relationships between their lives, the environment, social systems and institutions, but also to become active participants and decision-makers in the change process. In the same way, educators require a new set of skills, such as envisioning, critical thinking and reflection, dialogue and negotiation, collaboration, and building of partnerships. Rather than instructional approaches, constructionist and constructivist approaches seem more appropriate for the challenges of ESD.

The main challenge our research aims to tackle is to inspire people to make changes in their perceptions and behaviors toward sustainability issues. We believe that in order to achieve these results, sustainability education must embrace the central role of acquiring ecological knowledge through situated and shared experience in the natural, social and cultural world. The definition of the En Plein Air pedagogical model has been based on the analysis of relevant literature on mobile learning as discussed in the previous section, and the attempt to address the specific challenges of Education for Sustainable Development. In particular, it is based on three main concepts.

Authentic Experiences / Mobile technologies offer the possibilities to support learning activities outside the typical classroom context, allowing people to be engaged directly with the studied phenomena: the students discover and explore the topic in its natural context of occurrence, such as their neighborhood, community or specific natural environments. Learners can therefore establish a connection between sustainable issues and the immediate local context and reflect on their everyday living. The direct experience of the natural world or specific cultural issues related to a certain community of people is a fundamental aspect of ESD, in order to relate abstract knowledge to real human practices. This is fundamental in order to inspire and provide learners with the conceptual tool to operate a real change in the society.

Scaffolding / In order to guide students in the discovery of sustainable issues in their context of occurrence, it is fundamental to provide them with an activity structure: the complexity of the topics related to sustainability require to drive the students across different steps, supporting them to shift from the practical experience to the abstract knowledge and vice-versa. According to Sharples et al. [7] the level of control is an important challenge for any learning process. Mobile technologies can be used to relate specific contents to a certain geographic or social context, favoring a contextualized access to information and at the same time they enable learners to create content anchored to a specific place or situation.

Mixed learning pathways / within the realm of ESD, the direct experience of a certain topic in its natural context of occurrence is a fundamental aspect of the curricula. However, the possibility to negotiate with others and to reflect on the collected materials is also a critical part of the learning project. Indeed, the students can elaborate different point of views on the produced contents, discussing with others their personal system of values to frame the problem and negotiating possible interpretations of it. Furthermore, the possibility to reconsider the produced material is an occasion for the teachers to intervene in the learning project supporting the student to contextualize their observations within a more general and theoretical framework. The combination of Mobile and Web technologies can open the possibilities of distributed learning processes that can be modulated to favor situated and immersive experience as well as group discussions and critical reflections.

3.2. Learning Model and Activity Flow

The En Plein Air learning model capitalizes on the previous identified concepts and it has been used to customize the Locast software platform. In particular, the model is defined by four main activity phases that are supported by a different combination of Locast Web and mobile applications. The phases characterizing the En Plein Air learning model have been
defined taking into consideration four main variables: actors, tools, contents and context. Actors refer to people involved in the phase, such as teachers or any other professional involved in ESD or students (of different ages). The tools refer to the technology adopted in that specific phase, such as mobile or web application (CMS or website) of the Locast system. Contents refer to the digital materials that are created or manipulated during each phase, and context specifies the physical and social setting in which the activity take place and it can be individual or group-activity, indoor or outdoor. We have therefore identified four main phases of the learning activities supported by the Locast education platform, as it possible to observe in Figure 1 and Table 1.

Definition of the learning activities. The Locast Education platform contains the concept of “missions”. A mission defines the topic that the community of learners is invited to explore through the generation of location-based video reportages (called casts). Pre-recorded videos and “shooting templates” (i.e., close-up, long shot, reverse noddy, point of view) can be used to guide the learners during the missions and the creation of the casts. Video templates give the ability to dictate creative aspects, such as camera angles, or guide the content of the video itself, giving instructions to students while they shoot video for how to fulfill certain roles or what topics to speak on. Constructivist learning in physical context implies that it is necessary to provide freedom for creativity, while still providing guidance by scaffolding the activities. For example, a mission template could consist of a shot to introduce the topic of the mission, a set of shots to record the investigation and a terminating shot to conclude the results and the mission. However, the definition of missions is not mandated, and other kinds of learning formats can be utilized. According to different learning objectives, the teacher can choose which kinds of missions are more appropriate and consequently define the “shooting template” for each mission. Missions define also the social aspects of the activity, specifying if the activity is individual or if it is necessary working in groups and identify different roles (i.e., director, anchorman, etc.).

Creation of media content. In order to solve the mission, individuals or groups have to explore the environments and shoot the requested videos. The creation of media content is not
necessarily related to a specific mission and free shooting activity can be carried out. During this phase the learners can discover and study a certain phenomenon in its context of occurrence and with the guidance provided by the system to start elaborate a critical understanding of it.

Sharing. Casts are update in real-time on the Locast website and they are immediately available to the larger community of learners and other potential stakeholders. Learners have the possibility to access to different kind of devices (mobile or Web app) and to contribute in different ways to the achievement of the mission objectives.

Reflection and Negotiation. Casts can be explored and reviewed according to different modalities. The produced casts can be visualized on a map as location-based reportages, and all casts produced by a learner or a group of learners can be viewed in a narrative sequence, such that they compose a documentary. Casts produced by different learners can also be composed into the same documentary format to show the different point of views on the same topic.

3.3. Technological Implementation

The Locast platform consists of three main components. Locast Web: the web-based interface,
Locast Core: the backend and API, and Locast Mobile: the Android-based mobile application.

Locast Core is developed using Django, an open-source community driven web framework that allows for rapid creation of robust web applications. Django was primarily chosen due to the fact that it includes GeoDjango, a geographic module that enables the storage, querying, and manipulation of geographic information. Locast Core features an extensive network-centric API for interacting with client software. Through the API, data stored in Locast can be easily accessed and manipulated, allowing for a wide-range of visualizations, statistical analyses, and user interfaces. The Locast API is RESTful—a well-established API design pattern allowing for standardized communication over various client devices. Similarly, the Locast API makes use of JSON - a popular data-interchange format. JSON is based on JavaScript and is supported on nearly all-modern programming languages, allowing high flexibility for future development and design. The API is designed to support querying content based on all available cast characteristics, such as semantic tags, geographic data, and temporal information. For media content manipulation, Locast makes use of ffmpeg—a free open-source tool that is used for the conversion and manipulation of media data. The flexibility and power of ffmpeg allows to work across a multitude of disparate platforms, media formats and codecs.

Locast Web, which is also developed on the Django application framework, is the web interface for Locast. Locast Web provides a site on which users can search and interact with content, as well as submit content from sources other than the Locast Mobile. All map-based interactions and visualizations are handled by OpenLayers—a JavaScript library for displaying map data. Video casts are converted into a Flash format which are viewable on most modern web browsers and which can be embedded within various other sites and social networks.

Locast Mobile is an application developed for the Android Platform. It communicates with Locast Core using the provided API. All data on the mobile are stored in an SQLite database using the Android Content Provider framework. A custom synchronization engine handles change propagation, using last-modified comparisons to determine synchronization status and direction. Videos and audio casts are recorded using the Intent framework, thereby using the device-native media recorders. Locast also handles Intents to share videos, so other applications can integrate with Locast Mobile and allow users to publish their non-Locast created content.

4. EXEMPLAR EN PLEIN AIR USE CASES

Being a customizable software platform, Locast has been successfully used in a number of different projects (http://locast.mit.edu/). In order to support educational activities aimed to foster social and environmental sustainable actions, the platform have been specifically configured to support the En Plein Air pedagogical model and to address the challenges identified in the previous analysis. In what follows, we describe two use cases: Locast Reflect and Locast Direct-H2O Flow.

4.1. Locast Reflect

The first use case explores the potential of using templates as learning format. The (use case involved) learning tool was implemented for a group of MIT students participating in a course on French society and culture. The students were during the course committed to read literature related to French culture, urban exploration, identity and immigration. As part of the course the students experienced two weeks of tutored cultural immersion and cultural analysis in Paris and Marseilles. During these two weeks the students had an extensive schedule of lectures and seminars as well as visits to museums, institutes, neighborhoods and restaurants. By using Locast as platform a customized learning tool was implemented in collaboration with two of the teachers. During their visit in France the students were encouraged to use the Locast mobile phone application to record and share their reflections on cultural differences and their
implications. When entering the application the students were presented with six templates to choose from, representing six different themes possible to reflect upon (Table 2).

When selecting a template an associated video template was immediately activated. By providing the student with a set of sequentially appearing ‘shot directions’ on the screen the template was designed with the intention to trigger the students reflection on the topic while video documenting the situation (Table 3).

When the student had recorded the shots of the cast, it could be immediately uploaded to the server. Once uploaded, it became available on the website. The website provided for further reflection and education in the classroom when the students had returned from the trip.

4.2. Locast Direct–H2Flow

The third use case, H2Flow, exemplifies an implementation of missions and video templates as learning format. H2Flow was designed and implemented for an educational workshop.
The workshop aimed to teach the participants about global and local issues related to sustainable water use such as environmental impact of bottled water consumption and the predicted future of glaciers and other natural water resources. The students were involved in the creation of a video documentary centered on the subject matter. The students cooperated in groups of four to five persons, and conducted interviews, surveyed questions to the public, and participated in role-playing scenarios, where they took the role as reporters, environmental activists or private water company owners. Through this narrative and exploratory process, students studied the topic from a multiple perspectives: private versus public water, property, CO2 emission, climate change and melting glaciers as well as cultural value of water for the local community.

To participate, students used the mobile application to create geo-located video content. The mobile application was designed to moderate the learning process by providing missions to complete, as well as video templates that structured the individual videos themselves (Figure 3).

In the mobile application students were presented with eight missions, each dealing...
with diverse but interconnected aspects of the topic. Upon selecting a mission, an introductory video related to the subject was played and in the end of each video the student received an assignment to accomplish. To complete the mission the students were not only required to investigate and solve the assignment, but also to record video content such that it composed a scene in the documentary. Consequently, when the group had completed all missions the produced documentary would be composed of eight interconnecting scenes presenting the topic based on the students investigations and their own interpretation and understanding of the matter. To record the video content the students were provided with a set of six video templates to choose from, each comprised of eight shoots. The video templates not only guided the content of the video itself by giving instructions to students for how to fulfill certain roles or what topics to speak on, but also guaranteed short video clips and provided the ability to dictate creative aspects, such as camera angles. The six templates provided varied degrees of guidance. Some provided detailed directions for how to go ahead with the investigation and video recording while others provided more general structure for certain tasks such as to conduct an interview, make a video montage, or to record a Vox-pop (voice of the general public). Depending on the mission and how a student chose to approach it, different templates would work better than others; therefore, students were challenged to select a template that best corresponds to their understanding of the mission. Students could optionally make use several templates to compose more than one video to submit to a mission. When the students completed a mission, it was then uploaded to the website and later viewed in the classroom setting with the other students (Figure 4).

5. DISCUSSION

In this paper we have reviewed different approaches to mobile learning and we have discussed the En Plein Air pedagogical model to exploit the potentialities of mobile learning in the field of Education for Sustainable Development. The main thesis of the paper is that mobile learning offers a number of opportunities that can really improve the learning practice in this field; however, it is of fundamental importance to identify the appropriate learning approach in order to inform the design of the technological system. In particular, we have proposed a pedagogical model based on a number of theoretical assets derived from the education literature that has informed the design of the Locast platform. We have presented two use cases, in order to exemplify how the pedagogical model and the software platform have been integrated in concrete learning activities.

In this section, we would like to discuss broader implications and opportunities at the boundary between mobile learning and ESD and to identify five main assets that mobile platform for sustainability education should address.

- Place and project based learning approach. The Locast platform enables an explorative and place-based learning approach, meaning that the students explore different topics in their own local environments by actively engaging with members of the local community or discovering the surrounding physical space. By shooting their own documentaries as individuals or groups, or participating to exploration games, students observed fundamental natural processes in their context of occurrence. This is a fundamental asset of our pedagogical model and the Locast platform supports these kinds of activities by combining Mobile and Web technologies. Mobile learning offer the possibility to carry out learning activities in the wild, providing the learners with a tool to both receive contextualized information and generate new contents. The learners can therefore participate actively to the construction of new knowledge; by following specific structures (in our use cases Missions and Templates) the learners can interact with
the external social and physical world, document their activities and directly try to address specific problems as they manifest themselves in real context of occurrence. The ability to negotiate personal point of views and make sense of complex problems that admit a plethora of solutions is of fundamental importance in ESD.

- Situated critical thinking and reflection. The Locast platform “superimposes” a layer of digital contents within the physical space that was accessed through mobile phone stimulating critical thinking and reflection while directly exploring the nature in the wild. This specific feature of the Locast system supports the learner during their exploration of real context, providing specific and appropriate information. However, it is important to consider the level of invasiveness of this information during the learning process: while exploring the context in the wild, the system should guide and drive the students, stimulating them in critical reflecting on specific issues without absorbing all their attention capabilities.

- Anchored systemic thinking. The possibility to explore the digital materials on the web site map allowed students to contextualize their direct observations and to elaborate a critical understanding of the complex relations that characterize a natural ecosystem. In the Locast system, casts can be explored and reviewed according to different modalities: the produced casts can be visualized on a map as location-based reportages; all casts produced by a learner or a group of learners can also be viewed in a narrative sequence, such that they compose a documentary; casts produced by different learners can be composed in the same documentary to show the different point of views on the same topic. A very important issue is to connect outdoor activities with indoor activities, and therefore allow the student to shift from immersive and experiential to more reflexive and critical learning activities.

- Social Participation and real-time negotiation. People involved in the exploration activities and the larger community of learners

Figure 4. Locast web application: it shows the possibility to remix contents and have different perspective
established an on-going conversation and a continuous real-time negotiation process. The Locast platform, as an educational setting, enables learners to create personal narratives of the studied topic and to share it with the members of the learning community. The “internalization of what is outside” and the “externalization of what is inside” represent a developmental cycle: internal experiences are externalized through some shareable construction, which the learner can then re-internalize by reinterpreting it in its external form. This process can even become dialectic when the learner’s re-examination and reinterpretation of the internal and external forms produces a new synthesis of these distinctive expressions.

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