LEARNING ENVIRONMENT FOR GISCIENCE IN THE ERA OF FLYING ROBOT

Ass. Prof. Massimo De Marchi M. (1)
Dr. Eugenio Salvatore Pappalardo, PhD (2)
Dr. Daniele Codato, PhD (1)
Dr. Alberto Diantini (3)
Dr. Federico Gianoli (1)

1) Department of Civil Environmental Architectural Engineering - Master di Secondo Livello on "GIScience and Unmanned System for the integrated management of the territory and the natural resources ", University of Padova, **Italy**
2) Department of Historical and Geographical Sciences and the Ancient World - Master di Secondo Livello on "GIScience and Unmanned System for the integrated management of the territory and the natural resources ", University of Padova, **Italy**
3) Curricola Geographical Studies, PhD Regional Programme in Historical, Geographical, Anthropological Studies. Outline, University of Padova, **Italy**

ABSTRACT
The increasing availability of geographic information and the rapid development of new technologies for the management of geographic data (from drones, to WebGIS, to Mobile-GIS) require the updating, the reorganization and the development of decision-making processes in many sectors of the economy, public administration and the non-profit. At the same time Universities are challenged in providing suitable learning environment for updating and building appropriated skills. With the academic year 2015/2016 the University of Padua has launched the new Master di secondo livello on "GIScience and Unmanned System for the integrated management of the territory and the natural resources - with majors" (Professional Master). The master sees the collaboration of five departments, firms operating on GISciences and drones, NGO. The master offers 4 academic paths: Production and management of geo-information; GIScience for environmental conflict management and participation on public decision making; Cartography and GIS for green infrastructures; Geoinformation and new technologies for sustainable agriculture. With a first group of 25 people the Master started in March 2016 so we can share the first results participant observation of this initiative considering the complex context for GIScience and geography in Italy.

Keywords: GIScience, Drones, UAV, Italy, Professional master

INTRODUCTION

The technology of geo-information, along with the bio and nanotechnology, has been recognized by the scientific community as one of the three key technologies shaping the development of science, technology, and society in the next years [1]. Among the new technologies of geo-information, flying robots (or drones), entering into daily professional or personal life, at home and during leisure time, are driving a social revolution in the use of space and in the relationship among human beings, the environment and technology. At the same time citizens are becoming sensors [2] collecting data (actively or passively) on other people and the environment increasing voluntary (or involuntary) geographic information available due to the explosive growth of Web 2.0 technologies and the user-generated contents [3; 4].

Geographies of hope and fear [5] are coming? creation of dangerous agglomerations of power or points of resistance to power, decentralized global networks and multicultural cooperation in collective decisions [6]?. To address this challenge University can take fundamentally three directions: research, didactic and engagement in social dialogue.

In this paper we examine the role of University in its traditional mission of didactic, in the frontier of GIScience and technology of geoinformation. We examine the case study of a new professional Master at University of Padova (Italy) in the context of geographical education in Italian Universities.

THE CONTEXT: GISscience and geography in Italian Universities

In spite the need to answer the Klinkeberg question on geography of hope and fear, in Italy university opportunities to learn about geographical disciplines and GIScience are evolving in a sort of counter tendency considering the increasing of geographical technologies and information. In many bachelor and master programmes students have occasional contact with geographical disciplines ad GIS, normally limited to one or two courses during the entire programme. On the other side the 67 Italian public Universities in the academic year 2016/2017 are offering: 2 bachelors and 2 masters in geographical disciplines and nothing on GIS related issues. In 2002 numbers were significantly different: 63 public Universities, 11 bachelors, 4 masters in geographical disciplines and 4 bachelors in GIS. About PhD offer the panorama is almost scattered, geographers are members of many doctorate interdisciplinary programmes on human, social sciences or architecture and planning. However few PhD geographical scholarships are available in these interdisciplinary programmes about territory, local development or human and social sciences. Geography is central topic only in two doctorate programmes: the regional doctorate programme on "Historical Geographical and Anthropological Studies" (with a special curricula in geography) managed by the cooperation among the University of Padova, Venice and Verona; the doctorate on Geopolitics and Geo-economics offered by the private University Cusano in Rome. Concerning the organizations of geographical research the unique department of geography in Italy at University of Padova [7] merged in 2011 in the new "Department of Historical and Geographic Sciences and the Ancient World (DiSSGeA)", due to art. 2.2.a of Law 30/12/2010 n. 240 requiring the minimum of 40 professors to maintain a department in university with more than 1000 professors.

In the Italian qualification framework of higher education, universities offer also professional masters of first and second level (*Master di primo livello, Master di secondo livello*). This type of courses are offered under the autonomous responsibility of each university without the need of National Ministry authorization as in the case of bachelors (*Laurea*) and master (*Laurea magistrale*). Bachelor is the requirement to access *Master di Primo livello*, while Master to access *Master di Secondo livello*. For the academic year 2016/2017 the 67 Italian public universities are offering 2 programs of *Master di Primo livello* and 4 programs *of Master di Secondo livello* on GIScience and geographical related issues. For details see tables 2, 3, 4 showing also the discontinuity of the offer in the last 15 years.

In secondary schools, geography has been many years involved in disputes to find the appropriate space in ministerial educational programs. In the last five years the initiative "SOS Geografia" (http://www.sosgeografia.it) mobilized also civil society against Decree 12 September 2013, n. 104 and Law 8 November 2013, n. 128, reducing the space of geography in technical secondary education.

University and secondary school witness the complex situation of geographical disciplines and GIScience in Italy, with a long and consolidate difficulty for social and political recognition. Geographer is not commonly a recognized profession as engineer, architect, planner, sociologist, biologist, agronomist, economists, etc. But all these professionals use geographical tools, models and knowledge to solve their disciplinary tasks to sell consultancies and advices. Central and local governments do not hire services from geographers preferring other professionals. On the other side, the spreading of GIS and geographical knowledge due to university offer in the first decade of 2000 prepared a group of young professional interested in making geography either a profession either a social recognized ability. Caching the opportunities offered by new technology and social network, young geographers are commenting issues as immigration or international conflicts and offering skills to media and spatial analysis related sectors.

Table 1. - Active second level professional masters, key information

Master	Level	University	Department	Activity 15/16	Activation 16/17
Geomatics	I	Siena	Center for Geotechnology	yes	yes
GIS for Territory Governance	I	Camerino	Earth Science	yes	yes
Geographic Information Systems for Monitoring and Territory Management	II	Florence	Department of History, Archaeology, Geography, Art and Entertainment	yes	yes
Digital earth e smart governance. Strategies and GIS Tools for the Management of Territorial and Cultural Heritage	II	Roma Tre	Department of Humanities	yes	yes
Geoinformation and Geographic Information Systems to support the processes of Sustainable Territory Management and Territorial Security - Geo-GST	II	Rome "Tor Vergata"	Department of Civil Engineering and Computer Engineering	yes	?
Web Master in Geography and Territorial Identity in the New Teaching	II	Rome "Tor Vergata"	BAICR	yes	yes
Marine Geomatics. Advanced technologies applied to the marine environment	II	Genoa	Department of Marine Engineering, Electrical, Electronics and Telecommunications; Department of Earth Sciences, Environment and Life with the Navy Hydrographic Institute	yes	yes
Master in GIScience and Unmanned System for the integrated management of the territory and the natural resources - with majors	II	Padua	Interdepartmental - Civil Environmental Architectural Engineering ICEA; Geosciences; Historical and Geographic Sciences and the Ancient World - DISSGEA; Agronomy, Food, Natural Resources, Animals and the Environment - DAFNAE; Land, Environment, Agriculture and Forestry- TESAF	yes	yes

Source: http://statistica.miur.it/ and web sites of the universities - elaboration by the authors

Table 2 - Number of diplomas of active Second level professional masters

Master	University	04	05	06	07	08	09	10	11	12	13	14
Geographic Information Systems for Monitoring and Territory Management	Florence				7	7	11	6	8	10	13	3
Geoinformation and Geographic Information Systems to support the processes of Sustainable Territory Management and Territorial Security - Geo-GST	Rome "Tor Vergata"									5	11	10
Web Master in Geography and Territorial Identity in the New Teaching	Rome "Tor Vergata"	8	43	150	192	52	10	12	24	6	4	2
Marine Geomatics. Advanced technologies applied to the marine environment	Genoa		9			21		9	4		3	

Source: http://statistica.miur.it/ - elaboration by the authors

Table 3 - Number of diplomas on Second level professional masters not more active

Master	University	02	03	04	05	06	07	08	09	10	11	12	13	14
Geographic Information Systems and Remote Sensing (at distance)	IUAV			17	7	13	18	12		4	10	0	1	
Geographic Information Systems and Remote Sensing (in contact)	IUAV			9	6									
Space Remote Sensing Technologies	Bari								3	11	13	4	4	
Geographic Information Systems and Remote Sensing	Siena								5	7				6
Remote Sensing and Geographic Information Systems	Cagliari	10		13										
GIS and Remote Sensing The Geo-Environmental Planning	Roma Tre		21		5	30	11	20	7	4	10	13	16	
Geographic Information Systems Applied to Planning and Projecting of Urban and Rural Territory	"Sapienza" University of Rome			7	13			11	9	8				

Source: http://statistica.miur.it/ - elaboration by the authors

Table 4. - Number of diplomas on Second level professional masters related to total second level master diplomas issued annually by Italian public universities

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total diplomas On "GISscience" masters	10	21	54	83	193	228	123	45	61	69	38	52	21
Total diplomas In Italian master	1533	3875	7442	10440	11491	9907	11892	10816	12300	11231	11939	11583	12678
%	0,65%	0,54%	0,73%	0,80%	1,68%	2,30%	1,03%	0,42%	0,50%	0,61%	0,32%	0,45%	0,17%

Source: http://statistica.miur.it/ - elaboration by the authors

DESIGNING THE PROFESSIONAL MASTER

The design of the professional master started in 2014 to embrace three combined challenge at different scale: a cosmopolitan challenge of answering to Klinkeberg question on geography of hope and fear; at Italian level the discontinuity of opportunities for learning geography and GIScience, and finally, at local level (Padova University), the need to integrate in a common program numerous fragmented contributions.

Geographic Information Science has been considered, in continuity with international research and reflections [8; 9; 10; 11; 12], the opportunity to build bridges facilitating the dialogue among people and disciplines, the "common cause for interdisciplinary research" [13; 14; 15; 16], in the actualization of being geographer in the era of flying robots [8; 9; 17; 18; 19]. GIScience represents the learning environment in the long quest for a new integration among geography and cartography in the era of participatory and digital mapping [20]

To make this educational project comprehensible and communicable, considering few people in Italy understand what GIScience is, Unmanned Vehicles were chosen as paradigmatic technical and conceptual device: , Drones with its contemporary warfare implications [21; 22; 23; 24] allow reflections on technology and its social and environmental relations and implications in the challenge of "drones for good" [25; 26] . Flying robots are changing not only farm landscapes, but also urban and natural landscapes [27; 28], prospecting a new way of managing and leaving space, by handling the third dimension of a cubic space and the related geographies of hope and fear.

So, with the academic year 2015/2016 the University of Padua launched the new *Master di secondo livello* on "GIScience and Unmanned System for the integrated management of the territory and the natural resources - with majors". In Italian Qualification Framework, Master di Secondo Livello is a Professional Master available to people holding a Master degree. It represents level 8 of European Qualification Framework and lever 3 of Bologna Process of University Titles (1° level Bachelor, 2° Level Master, 3° level PhD and Professional Masters. *"Second-level university master courses are aimed at scientific specialization training and higher continuous training, the length of the study is at least one year (60 credits)"* [29]. The Professional master sees the collaboration of five departments: Civil Environmental Architectural Engineering, (ICEA), Department of Historical and Geographic Sciences and the Ancient World (DiSSGeA), in particular the section on geography; Department of Geosciences; Department of Agronomy, Food, Natural Resources, Animals and the Environment (DAFNAE); Department of Land environment, Agriculture and Forestry (TESAF). The Master intends to prepare multipurpose professionals, adopting interdisciplinary approaches typical of GIScience, GIS systems and innovative technologies of remote sensing (drones, satellite imagery, LiDAR) on a wide range of analytical applications and tools for the sustainable management of the territory and its resources. The master offers 4 academic paths: Production and management of geo-information; GIScience for environmental conflict management and participation on public decision making; Cartography and GIS for green infrastructures; Geoinformation and new technologies for sustainable agriculture.

The Master aims to prepare professionals able to: use appropriate interdisciplinary approaches, technological solutions and geographic information in addressing complex territorial issues; acquire, represent and analyze geographic information to spread expert use and to support complex decisions; manage the transformation of technologies supporting GIScience and orienting the identification of appropriate solutions for businesses, government agencies, and citizenship.

Pedagogy behind the project is not just based on technical training, but in a wide approach combining adult education, cooperative learning to develop critical thinking [30], increase motivation and experiencing collective intelligence [31; 32] to navigate the environment of life long learning [33].

The Master takes the approach of learning in the situation, alternating lectures, practical examples and immediate experimentation, working group, fieldwork, taking advantages of digital earth approach [34; 35]. Master is divided into 32 credits of common courses, 10 CFU for each academic path and 18 credits of stage. There are 336 hours of lectures, 714 hours of individual study, and 450 hours of stage for a total of 1,500 hours, corresponding to 60 credits. Considering the complex regulation system for UAV in Italy, a strategic partnership with two firms specialized in drone services (FTO Remotefly and Archetipo) allows the learning and research activities of the professional master and the completion of training to deliver to participants the fly permit RPAS (Remote Pilot Aircraft System).

Table. 5. Didactic structure of the Professional Master on GIScience and RPS (Remoted Pilot Systems)

Common courses (32CFU)			
From geography of complexity to GIScience: territories, places, landscapes and sustainability (2CFU)			
From the topographic map to the physical landscape: interpretation of geomorphology (2CFU)			
Biodiversity and ecosystem services in land planning (2CFU)			
History of cartography and the use of historical maps in Geo-historical reconstruction (2CFU)			
Between professional GPS and mobile GIS: survey and reference system for cartography (2CFU)			
GIS: structure, functions and models for territorial vector data con QGIS (2CFU)			
Raster analysis with ArcGis and QGIS-GRASS (2CFU)			
Geo Database Open Source and geospatial data structures with Postgresql / PostGIS (2CFU)			
WebGIS design and management (2CFU)			
Remote sensing: data acquisition and geological applications (2CFU)			
Remote sensing: applications in geomorphology and environmental management (2CFU)			
Remotely Piloted Aircraft Systems (RPAS), law and criteria for operations (2CFU)			
Unmanned Systems for territory and resource management (2CFU)			
Cartography and GIS in Spatial Planning (2CFU)			
Participatory GIS and methodologies for inclusive public decision making (4CFU)			
Academic path courses (10CFU)			
Path 1	**Path 2**	**Path 3**	**Path 4**
Production and management of geo-information	*GIScience for environmental conflict management and participation on public decision making*	*Cartography and GIS for green infrastructures*	*Geoinformation and new technologies for sustainable agriculture*
Stage or project work (18CFU)			

Courses of Academic Paths	**1**	**2**	**3**	**4**
Digital terrain models and geomorphometry (2 CFU)	X			
Digital photogrammetry and structure from motion (2 CFU)	X			
Modern survey technology (2 CFU)	X			
Information Modeling and Management (IMM) for buildings (BIM) and infrastructures (IIM) (2 CFU)	X			
Geothematic cartography (2 CFU)	X		X	
Territories of citizens: geography and GIScience for the management of socio-environmental conflicts (3CFU)		X		
Digital Earth, voluntary geography and mapping of ecosystem services (3CFU)		X		
Mobility and Transport: quality of information and quality of decisions (2CFU)		X	X	
Landscapes social and ecological networks (2CFU)		X	X	
Design of green infrastructure (2CFU)			X	
Geoinformation and technologies for the description of animal movement (2CFU)			X	X
Precision farming and unmanned systems (2CFU)				X
Remote sensing for plant phenomic analysis (2CFU)				X

Assessment of water and carbon budgets of crops through advanced remote sensing techniques and ground truth (2CFU)				X
Spatial statistics and geostatistics for sustainable agriculture (2CFU)				X

FIRST RESULTS FROM PARTICIPANT OBSERVATION OF THE FIRST COHORT

As highlighted above, the approach of this professional master is based on a combination of adult education and cooperative learning, granting a coordination among the different phases of the programme, individual and group tutoring and mentoring during the different activities. Participant observation is used either to tune activities either to collect information for monitoring and evaluation of the programme in a sort of ethnographic immersion in the educational context. Observation diaries are integrated with specific activities to collect feedback on the programme, facilitating collective evaluation of learning processes combining group based methods, questionnaires and skill assessment formats. To participate at the selection for the admission, applicants attached a motivation letter describing in detail the reasons to apply to the professional master and the areas the candidate intends to deepen in field of: GIScience, Unmanned Systems, the integrated management of territory and natural resources. These texts were used not just for individual selection, but also to grasp common element characterizing the educational community of the applicants. Learning activities started day 03/03/2016 with the building of learning pacts. Participants through post-it were asked to express expectations and fears for the beginning of a new experience. Shared expectations were about "new knowledge and professional" skills meanwhile shared fears were about a program "not just theory". However many other elements related to a good climate for learning were shared during discussion, especially about motivation, avoiding superficiality, and creating a stimulating context. Table offers the profile of the 25 participants.

Table 6. Profile of 25 people participating at the professional Master on GIScience and RPS

Sex	Age	Master	Year from graduation	Profession
M	25	Geology	0	Consultant
M	27	Forestry	0	Unemployed
F	27	Geography	0	Waitress
M	28	Forestry	0	Unemployed
M	49	Forestry	0	Civil servant
F	27	Architecture	1	Consultant
F	28	Engineering	1	Consultant
M	28	Natural Sciences	1	Consultant
M	33	Architecture	1	Consultant
M	28	Geology	2	Consultant
M	38	Archaeology	2	Consultant
M	32	Archaeology	3	Unemployed
F	32	Palaeontology	3	Civil servant
F	33	Forestry	3	Unemployed
F	30	Planning	4	Consultant
M	33	Economy	5	Researcher
M	36	Environmental Science	5	Consultant
F	38	Archaeology	6	Consultant
M	36	Natural Sciences	9	Unemployed
F	41	Natural Sciences	9	Consultant
F	37	Engineering	11	Civil servant
W	42	Planning	13	Civil servant
M	43	Engineering	13	Consultant
M	41	Engineering	14	Teacher
M	42	Geology	15	Consultant

In the first week of the programme a skill assessment questionnaire was submitted to participants about 98 topics grouped in 10 areas: conceptual foundations; cartography and representation; GIS data and applications; remote sensing and photogrammetry; Remoted Pilot Systems; Integrated management of territory and natural resources; GIScience and society; Software use; data types; remote sensing products. For each topic participants can express two values: knowledge about the issue (I've never heard... I heard but I do not know... I know) and skills in a scale of four values (1 minimum, 4 maximum). Considering the *Master di Secondo Livello* is a 8 level qualification in the EQF framework and a 3° level in the framework of academic titles, key elements of results and evaluation are confronted with of Dublin descriptors: Knowledge and understanding, Applying knowledge and understanding, Making judgements, Communication, Lifelong learning skills. At the end of the master, participants have to acquire two clusters of skills: first, transversal competences to manage complex decision through skills developed in the context of PGIS processes: management of inclusive decision-making processes and environmental conflicts; facilitation in the construction of social maps; participatory scenario development. Then skill related with GISscience, RPS and management of territory and natural resources as: modelling and structuring of spatial data; acquisition and management of spatial data and assessment of the need for Unmanned Systems Operations; spatial analysis; mapping and spatial data visualization; planning and organization of spatial data infrastructures and WebGIS; management of GIS projects; design and management of spatial database; management and valorisation of spatial data; design of green infrastructures (green and blue); design of ecological networks and connections between protected areas; mapping of ecosystem services; management of city parks and connection with green infrastructure; design of land and water ecological corridors.

CONCLUSION AND PERSPECTIVES

The learning environment initiated by the professional master intends to answer to two clusters of challenges. The first cluster is about a multi scale approach: from the earth responsibility of answering the Klinkenberg question, to the local scale at Padova University. The second cluster is about creating a cooperative learning environment, building dynamics community combining multiple objectives: for improving professional opportunities, alimenting scientific curiosity, experience active geographical citizenship. The framework offered by RPS and GIScience can be effective by deepening and recognizing the root of geography and recuperating of ties sometimes cut with cartography and technology. The social implication of GIS and geographical technologies have always been one of the main areas of research in GIScience [36]. Geographical education is a place to work with other geographers and scholars of other disciplines to address the challenges of geo-spatial technologies.

Participant at professional master have the opportunity to live a multidisciplinary and interdisciplinary environment reconnecting the continuity of geographical knowledge with the innovation of Information and Communication Technology (ICT) and their appropriate use as a conceptual framework to read the complex territorial issues and to frame appropriate decisions. At the same time, this active community allows a cooperative building of the ability to develop and implement high intellectual added value professional interventions suitable for different institutional contexts, responding to the needs of the different local actors and based on the appropriate use of GIScience. Each participant in the relations with the professional master community can acquire the own autonomy for professional intervention in GIScience to operate in the market of high intellectual added value consultancy at national and international level. Other key element is the acquisition of communication skills either in the context of GIScience, either in the use of geographic information and innovative technologies in the contexts of complex decision, articulating the appropriate dialogue

among social partners, supporting the decision makers, debating with other expert. Finally, the learning community activated represent a meeting point to promote the growth and development of professional expertise in the field of GIScience and inclusive decision-making process, with the awareness that the technological solutions should be contextualized in a long-term perspective with clear discernment of what is really innovative and suitable in providing significant change.

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