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**The Teaching Approach to Geosciences in Early Italian High  
School: recent Trends and new Perspectives.**

PhD Thesis

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I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person.

*“There is no science without fancy and no art without fact.”*

*V. Nabokov*

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## **1. ABSTRACT**

In September 2010, a new high school reform came into force in Italy. The new regulatory framework introduced significant changes in the teaching of Natural Sciences.

One of the most relevant of these changes is the introduction of Geosciences topics in high school programs from the first school year, to be taught together with biology and chemistry through all the five years of secondary school. In a few years, this small revolution in the field of the high school's scientific education, other than concerning hundreds of thousands of young students, has in a way heavily involved text authors and editors responsible of producing, in the shortest time possible, new textbooks consistent with national guidelines, and on the other way has imposed to Italian teachers the revision of consolidated working routines. At the same time this reform has presented itself as an occasion to innovate and to experiment new didactic path.

This PhD project has been developed in the range of this modified regulatory, as well as educational context.

The main target of the first part of this research has been to show the effect of the reform on the Italian reality on various levels: that of authors/editors of textbooks, that of teachers and that of students.

The first phase of this research has enlightened a widespread difficulty for Italian in-service teachers in putting into practice national guidelines for the first school year, for what concerns topics regarding Earth's surface considered from a geomorphological point of view (25% of the curriculum).

The aforementioned topic, if examining the school programmes conducted during the first year by a sample of teachers over the whole national territory, is, if not totally absent, very marginalized. On the contrary, in the choice of said programmes we can read a tendency of preserving teaching routines consolidated in time, even if these propose topics not contemplated by the reform guidelines (for example astrophysics topics).

These data fully reflect the ones concerning Geosciences textbooks most popularly adopted in first year classes: with a few exceptions, we find textbooks lacking a structure comprehending the study of geographical features and shapes and the processes involved therein, while an encyclopaedic structure is preferred, presenting a variety of topics much more abundant than those required by national guidelines.

For what concerns a student's point of view, we conducted a questionnaire survey to evaluate the interest and attitude towards learning Geosciences that a sample of Italian students might have matured in the transition from lower to upper secondary school. Our data suggest that lower secondary school exposure to Geosciences promotes a great interest in the subject area, as well as a comfort level in the subject at the entrance to the Lyceum. Furthermore, the analysis also pointed out that students have a higher probability of showing a high awareness on Geosciences topics if they frequently undertake outdoor activities. Students were also asked which didactic methods they preferred in learning Geosciences; their answer to our questionnaires indicated a clear preference for practical and in-field activities, rather than traditional frontal lecture approaches. Nevertheless, the school was included in their answers at the last place as a promoter of field experiences.

These results, together with those emerged from a parallel study on pre-service science teachers' attitude in planning field trips for Geosciences learning at secondary level, suggested the need to change the teaching paradigms.

As a consequence, the second phase of the doctoral project focused on the design and testing of a new didactic path for the 1<sup>st</sup> year scheduled Geosciences contents.

Thus, to find solutions to the difficulties encountered by in-service science teachers in responding to the reform's national guidelines, an educational module focussed on *the reading of the landscape* with an inquire-based approach was devised and tested with a sample of Italian High school teachers and their students. A qualitative - quantitative explorative case-study was run by collecting data with pre-and post intervention questionnaire aiming to shed light on some aspects of module's effectiveness. According to answers, Teachers and students are unanimous in judging the employment of this kind of approach in learning as a promoter of greater interest and inclination towards Geosciences treated topics and a greater stimulation to study these subjects compared to a traditional approach.

In conclusion, the results presented in this thesis shed light on the impact of the so called Gelmini reform on the Italian Geosciences teaching and learning praxis at the first year of high school and represent a contribution for a better understanding of the impact of Inquiry based approaches in the learning of Earth landforms and related geomorphic processes which had never been implemented before in the Italian context.

## 1. RIASSUNTO

Nel Settembre del 2010 entrava in vigore in Italia la riforma della scuola secondaria superiore. Col nuovo quadro normativo venivano introdotte importanti novità nell'insegnamento delle Scienze Naturali *sensu lato*. Tra queste una delle più rilevanti è consistita nell'introduzione dello studio delle Geoscienze nei curricula dei licei già a partire dal primo anno e da insegnarsi in parallelo con la biologia e la chimica per tutti e cinque gli anni. Questa piccola rivoluzione nell'ambito dell'istruzione scientifica liceale, nel volgere di pochi anni oltre a toccare centinaia di migliaia di giovani studenti, ha da un lato coinvolto massicciamente autori di libri di testo ed editori chiamati a produrre nel più breve tempo possibile nuovi manuali in linea con le indicazioni nazionali, dall'altro ha imposto ai docenti italiani la revisione di alcune prassi di lavoro consolidate, ma nello stesso tempo si è presentata come un'occasione di sperimentazione e di innovazione.

Nell'ambito di questo mutato contesto normativo e didattico si è articolato il progetto del dottorato. Obiettivo della prima parte della ricerca è stato quello di fare luce sull'impatto che la riforma ha esercitato nella realtà italiana a più livelli: quello degli autori/editori di testi scolastici, quello degli insegnanti e quello degli studenti.

La prima fase della ricerca ha messo in luce una diffusa difficoltà della classe docente italiana a mettere in pratica le indicazioni nazionali per il primo anno, per quel che concerne la trattazione dello studio della superficie terrestre da un punto di vista geomorfologico (il 25% del curriculum). Tale parte, dall'esame dei programmi svolti al primo anno di un campione di docenti preso su tutto il territorio nazionale risulta, se non del tutto assente, molto marginalizzata. Nelle scelte di programmazione si legge piuttosto la tendenza a conservare prassi didattiche consolidate nel tempo anche se queste comportino la proposizione di temi non previsti dalle indicazioni della riforma (ad es. elementi di astrofisica).

A questo dato fa eco quello sui libri di testo di Geoscienze più adottati nelle prime classi: a parte poche eccezioni, si tratta di manuali privi di un'evidente strutturazione incentrata sullo studio delle forme del rilievo e dei processi coinvolti, mentre è privilegiato un taglio enciclopedico in cui figura una varietà di temi di gran lunga superiori a quelli richiesti dalle indicazioni nazionali.

Per quanto riguarda il punto di vista degli studenti, abbiamo sottoposto ad un campione un questionario per valutare il grado di interesse e attitudine verso le Geoscienze maturato al momento del passaggio al Liceo. I dati suggeriscono che gli allievi arrivano dalla Scuola secondaria di primo grado con un elevato livello di interesse e adeguati prerequisiti per affrontarne lo studio. Inoltre è emerso che gli studenti mostrano una familiarità verso le Geoscienze tanto più alta quanto più hanno praticato attività outdoor. Infatti invitati a indicare quali fossero le metodologie di apprendimento preferite nell'affrontare tali discipline hanno indicato le attività di campo e di laboratorio al primo posto. E ciò nonostante la scuola figurasse nelle loro risposte, all'ultimo posto come promotrice di esperienze di campo.

Questi dati, insieme a quelli emersi da uno studio parallelo sull'attitudine a progettare attività di campo da parte degli insegnanti di scienze in formazione, hanno suggerito la necessità di cambiare paradigmi didattici.

L'ideazione e la sperimentazione di un diverso approccio didattico per lo svolgimento degli argomenti di Geoscienze del primo anno dei Licei costituiscono l'ambito in cui si sviluppava la seconda fase del progetto del dottorato. In tale contesto, per trovare delle soluzioni agli ostacoli incontrati dai docenti in servizio nel portare a termine quanto previsto dalle indicazioni nazionali, veniva ideato e testato, insieme ad un campione di docenti e loro studenti, un modulo per l'insegnamento della lettura del paesaggio basato su un approccio di tipo investigativo. Specificamente veniva effettuato uno studio quali-quantitativo di natura esplorativa, per mezzo di questionari pre e post intervento didattico, in modo da misurare la fattibilità e l'impatto del modulo nel conseguimento degli obiettivi educativi. Dai dati è emerso che docenti e allievi sono unanimemente concordi nel ritenere il tipo di approccio sperimentato molto più efficace nel promuovere interesse e attitudine verso gli argomenti di Geoscienze in oggetto, così come nel motivare allo studio, rispetto ad uno più tradizionale.

Nel complesso, i risultati presentati in questa tesi fanno luce sull'impatto che la cosiddetta riforma Gelmini ha esercitato sulla prassi didattica delle Geoscienze al primo anno della scuola superiore italiana e al contempo costituiscono un contributo per capire l'influenza che l'adozione di un approccio didattico di tipo investigativo può assumere nel promuovere l'insegnamento e l'apprendimento dello studio delle forme del paesaggio e dei processi ad esse connesse, in precedenza mai sperimentato nel contesto italiano.



## 2. INTRODUCTION

*Novelties of the legal framework and significance of the present research.*

Apart from some changes experimentally introduced in the 1990s with the adoption of the guidelines devised by the Brocca ministerial commission (VV.AA, 1991), the Italian secondary school was awaiting a comprehensive reform of its system since 1923, year of the reform by the Minister Giovanni Gentile.

The need for a renewal in the teaching of the natural sciences *sensu lato* concerning both the programs and the methods had long been invoked. In fact, with regards to the scientific expertise Italy was ranked 36<sup>th</sup> in the 2006 PISA (Programme for International Student Assessment) survey, several points below the average of the OECD countries (OECD, 2007).

By Presidential Decree, on March 15, 2010 the Gelmini law (named after the then Minister of Education) came into force, introducing new provisions to reorganize the secondary school system and its three courses of studies: the professional one, the technical one and the lycei. The law would become operational with the start of the 2010-2011 school year and its first cycle would end with the 2014-2015 school year (D.P.R. No. 89, 2010).

From its outset, the Gelmini law became the subject of an intense debate between the public administration on one side, and the teachers and the trade unions on the other. In fact, the reform provided for a substantial re-sizing of the school hours with as immediate effect a reduction of the teaching posts and, hence, jobs.

The essentially economic consequences of the reform monopolized the discussion diverting for a long time the attention from the changes that, through the adoption of new curricula, were introduced in the programs and therefore in the didactics (DM 211/2010).

In fact, although the first five years of the reform have recently come to an end, looking at the relevant literature, it is striking how little attention has been paid to the changes that the new regulations have produced in the Italian secondary school teaching practice. With regards to the field of science teaching, there are only four matter reports (Tosetto, 2011; Marini et al., 2012; Fiussello et al., 2016; Realdon et al., 2016).

For this reason, the present PhD research project, albeit limited in terms of scope to the changes introduced in the teaching of science for the first year of the new Lycei, can make a

significant contribution in shedding light on the impact that the recent reform has had on science teaching in the Italian school.

*National guidelines for Lycei and the new role of Geosciences in the curricula*

With regards to secondary school education, the new guidelines provided by the reform have introduced a significant novelty in the teaching of science: the three disciplines that traditionally it comprises, Biology, Chemistry and Geosciences are now to be taught in an integrated way right from the first year and throughout all five years (DM 211, 2010).

In particular, the Geosciences, which before were confined to the last year, are now a first year teaching subject, according to which the student are expected to study the surface of the planet from a geomorphological point of view.

On paper, the reform gives a greater educational weight to geosciences in the secondary school and this is in line with the current international trends, as stressed by Chris King, one of the foremost scholars in the field of geosciences secondary school teaching: “*Geoscience education is gaining increasing prominence within school science education in a number of countries worldwide. Given this growth of interest, there is an urgent need for a detailed scholarly analysis of research in this area.*” (King, 2008 p.187.)

This makes the present research all the more relevant and urgent.

Finally, in outlining the background against which the project has developed, a further fact has to be pointed out: the author himself has worked as a secondary school science teacher, teaching geosciences continuously as tenured teacher from the 1999-2000 school year up until the beginning of the present PhD (2014), thus experiencing first-hand the transition process imposed by the reform as well as taking part as a speaker at the guidance meetings organized for the interpretation of the new national guidelines by the Natural Sciences Teachers National Association (ANISN) of the Piedmont Region. The present research is therefore focussed on how to implement the guidelines for the Geoscience program of the first year of secondary school based on personal experience as well as on the exchange of ideas with colleagues both at school and at the guidance meetings. In fact, though the implementation of the programmatic points for the first year has been a knotty operational problem right from the very beginning, at the same time it also represents a challenging opportunity for innovation.

To better understand the impact that the new reform has had on the educational system with regards to Geoscience teaching, firstly an effort has been made to figure out and understand the point of view of:

- i. textbooks authors (**chapter 3**)
- ii. teachers in service (**chapter 3**)
- iii. students beginning their secondary school education (**chapter 4**)
- iv. pre-service teachers in training (**chapter 5**)

Once the main operational obstacles encountered by teachers during the planning and implementation of the programs were brought to light, and the conceptual and methodological obstacles envisaged by the students who were about to face the study of Geosciences in the secondary school were defined, the goal of the research became to devise and experiment an innovative methodology in the first year Geoscience subjects and to test its effectiveness by comparing it to the traditional approach.

In particular, this was accomplished by devising and subsequently experimenting with a sample of secondary school classes an inquiry based teaching module on landscape reading which connects in an interdisciplinary way the science and the geography syllabus (**chapter 6**).

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3.

## TEXT BOOK' AUTHORS AND SCIENCE TEACHERS FACING THE SECONDARY SCHOOL REFORMED CONTEXT

- *Sturani, M. (2016). Teaching Physical Geography in Italian High Schools (Licei): current situation and perspective. Rendiconti Online Della Società Geologica Italiana, 40 91–98.*

# Teaching Physical Geography in Italian High Schools (*Licei*): current situation and perspective.

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## ABSTRACT

Physical geography as a discipline is not included in national Italian high school's curricula, even though it is supposed to be taught as part of the natural science programmes, especially after the 2010 reform of the Italian secondary school system. In particular the reform introduce the study of physical geography for the first time to first year classes in specialized upper secondary schools known as "licei". A survey based on open data shows that Geosciences textbooks released after 2010 tend to offer a broader range of topics than intended by the reform's framework, which provides teachers ample freedom in scheduling. The data, however, also reveals that only a small percentage of science teachers strictly follows the national guidelines, while the majority allocate a very small amount of their schedule to physical geography. This reveals a minor influence of Geosciences in Italy's approach to the teaching of general science at high school level. The new reform even if it lacks of implementing information for teachers suggests that both the importance attributed to physical geography in the curricula and the related teaching methods used need to be improved. This meets the need to increase Geosciences literacy in scholar population in order to develop an active and responsible attitude towards environmental challenges and hydro-geological risks, which are a distinctive aspect of Italy's territory.

## RIASSUNTO

*Nella prassi didattica della scuola secondaria superiore italiana la geografia fisica non figura come una materia a sé stante, tuttavia essa viene tradizionalmente insegnata nei corsi di scienze. In particolare a partire dal 2010, per effetto della riforma della scuola superiore (secondaria di secondo grado), essa è stata introdotta fin dal primo anno del corso di studi nei licei. Una ricerca basata su open data mostra che i libri di testo di Scienze della Terra per il*

*primo anno, editi a partire dal 2010, tendono ad offrire un ventaglio di argomenti molto più ampio di quello previsto dal quadro normativo consentendo ai docenti ampia libertà nella programmazione. Allo stesso tempo una ricerca condotta su un campione di programmi svolti a fine anno dai docenti mostra che solo una piccola percentuale di essi, nel merito dell'insegnamento della geografia fisica, tende ad attenersi alle indicazioni della riforma. Ciò sembra suggerire uno scarso peso esercitato dalle geoscienze nella tradizione didattica italiana della scuola superiore. Tuttavia la riforma suggerisce che lo spazio dedicato all'insegnamento della geografia fisica vada implementato e ciò pur considerando la mancanza di informazioni che accompagnano il disegno normativo utili alla sua messa in atto. Questo risponde alla necessità di formare cittadini più sensibili e responsabili verso i temi dei cambiamenti ambientali in atto e sui loro effetti sui fragili equilibri idrogeologici che sono una peculiarità del territorio italiano.*

KEY WORDS: Geosciences teaching, physical geography, Italian “licei” national curriculum, high school.

*PAROLE CHIAVE: didattica delle Scienze della Terra, geografia fisica, indicazioni nazionali per i licei, scuola secondaria di secondo grado.*

## INTRODUCTION

In the Italian didactic tradition, physical geography (including the study of atmosphere, meteorology, climatology, hydrology and geomorphology) has normally appeared at the end of the science course curriculum (5<sup>th</sup> year course) of a few specialized upper secondary schools known as “licei”. Before the 2010 school reform, the national curriculum required physical geography to be taught within the natural science programme of the fifth year and was mentioned in the national guidelines as the study of the “exogenic processes involved in the Earth’s dynamic”. This section formed only a part of the Earth and Space Science programme, which included topics such as mathematical geography (i.e. the study of the Earth’s size and shape, time zones and motion), astronomy and geology. Until the mid-1980s, however, physical geography was still one of the main subjects of the final high-school exit exam (“Esame di Maturità”).

Subsequent developments though - particularly the plate tectonics paradigm, which started to feature in the majority of teachers' programmes - relegated physical geography to a secondary role, while mathematical geography and astronomy continued to be central topics of study. Plate tectonics paradigm was such a perfect tool to interrelate geology, volcanism and seismology that endogenous dynamics prevailed on exogenic ones in teacher's scheduling.

In 2010, the Italian government issued new guidelines for the secondary education system (Riforma Gelmini, DPR 89/2010). The natural science programme of study, which traditionally includes biology, chemistry and Geosciences, was subject to significant changes, particularly in the "licei". According to this new reform, all science courses must teach these three disciplines vertically and simultaneously during the course of the five years of secondary school, whereas before 2010 they were being taught separately. Another important change is the fact that Geosciences has now been introduced for the first time to first year classes in several types of "licei".

The national curriculum guidelines for the first year (fig. 1) identify mathematical geography and physical geography as the two key disciplines. As a result of this reform, physical geography (especially hydrology and geomorphology) once again assumes a central role in science learning.

LICEO SCIENTIFICO: 2010 GEOSCIENCES CURRICULUM' KEY CONTENTS	
1st/2nd years science course (mainly in the 1st year) 2h lessons/week*	<ul style="list-style-type: none"> <li>• Earth's motions and their implications</li> <li>• Earth surface from a geomorphological point of view</li> </ul>
3rd/4th years science course 3h lessons/week*	<ul style="list-style-type: none"> <li>• Minerals and rocks</li> <li>• Volcanoes and earthquakes</li> <li>• Earth surface from a geodynamic point of view</li> </ul>
5th year science course 3h lessons/week*	<ul style="list-style-type: none"> <li>• Meteorology</li> <li>• Plate tectonics</li> <li>• Further exploration of already treated arguments</li> </ul>

*Fig. 1* – The scheme shows the framework of Geosciences key contents through the whole five years course as indicate in 2010 national curriculum (Decreto Interministeriale 211 del 7 ottobre 2010, Gazz. Uff. 14 dicembre 2010, n. 291).

(\*) Time table refers to general science course of which only a fraction is dedicated to Geosciences topics the remaining portion covers chemistry and biology.



## THE NEED OF A SURVEY

A review of the current literature in the field of geoscience teaching in Italy shows how, in the last decade, some authors have been exploring new ways of teaching Geosciences at a high school level by proposing a new paradigm (Venturini, 2009; 2010), suggesting more interaction and a hands-on teaching approach (Greco, 2009), as well as introducing and experimenting with ICT (Information and Communication Technology) to implement Geosciences teaching/learning both in classroom and field contexts (Magagna, 2013, 2014; Giardino, 2014). As for Geosciences teaching under the new reform, two important reports (Tosetto, 2010; Marini *et al.*, 2012) make a general assessment of the results of this reform and highlight some of its critical aspects. Another interesting study takes a comparative perspective and looks at how the new Geosciences high-school curricula are taught in three European countries (Greece, Italy and Spain) to identify what are the students' main topics of interest (Fermeli, 2015).

Excluding these studies, very little is known about physical geography teaching tradition at high school level in Italy. Besides, interesting approaches in physical geography teaching, including fieldwork laboratories, new technologies and inquiry approaches have been tested at lower secondary school level (e.g., Garavaglia & Pelfini, 2011; Bollati *et al.*, 2012). Finally, there is an important research study that focuses on secondary level Geosciences textbooks from the mid-1980s to the early-1990s, where the most common didactic paradigms chosen in high school by teachers at that time are indirectly highlighted (Piacente, 1992).

At present, even though national guidelines, as they are written, are considered to be far from exhaustive and precise – since they are basically limited to a table of contents – if one looks at the new reformed features (fig.1), physical geography assumes a central role in the first year curriculum in the “licei”, covering at least 50% of its size. This is further born out by first year's Geosciences national curriculum recommendations and learning goals, which state that the whole programme has to be integrated with the geography syllabus. In situations where there is a short amount of time available, science and geography teachers are supposed to coordinate their efforts (Tosetto, 2010). Such subject-coordination suggests that among the supporting concepts of the first year science course there are those of physical geography.

This is not entirely new in the Italian didactic tradition, since a similar curriculum was designed for first year courses in a previous experimental reform project, the *Natural Science - Brocca's experimental class* (VV.AA, 1991). This reform, however, never came into full effect and, even though it has been running for more than a decade in various schools, no reports exist to give us an overall assessment of these curricula. Taking into account all of the above and the fact that 2015 marks the closure of the first cycle of newly reformed “licei”, we believe that a survey is called for to better understand how physical geography is taught in the context of this new reform. Piacente (1995) argues that in the history of the Italian education system, which took over fifty years to be reformed, the absence of detailed information has allowed authors and publishers of science textbooks to play a crucial role in introducing new paradigms in the didactics of Geosciences. For this reason we decided to start the survey by looking at new science textbooks, published after 2010, in order to answer the following key questions:

- How do authors of school textbooks actually interpret the new national guidelines?
- How many new science textbooks fit the general national guidelines?
- What textbooks, published after 2010, do teachers predominantly select?
- In the new textbooks, how much space is given to physical geography - especially geomorphology- and to other Geosciences sub-disciplines?
- Are new textbooks for the first year course in the “licei” structured around physical geography supporting concepts?
- Do recent textbooks introduce important changes or new focus topics in the teaching of physical geography?

We then completed our study by analyzing what a sample of Italian teachers stated in their final course reports in order to answer the next set of questions:

- What weight does physical geography, and geomorphology in particular, carry in the teacher's first year science programme?
- Is annual scheduling driven by physical geography supporting concepts?
- How many implemented-programs are adherent with the national curriculum guidelines?

## METHOD

### 1. The textbook survey

AIE (Associazione Italiana Editori) provided us with the list of all Italian high school Geosciences featured in general publisher catalogues. The list includes more than 400 titles. In order to find out which were the most selected ones by the teachers within the list, we consulted the titles published on the internet by the majority of the Italian high schools. Each list provides a set of selected books for all disciplines. Before we gathered the data, we drew a sample equivalent to 20% of the “Licei scientifici” across Italy. The size of each region’s student population was taken into account when establishing the respective proportions of “licei” (20%). We then collected a single data for each school website. In total, 213 titles were selected using this method. Many of the published books figures in different versions which varies for presence/absence of appendix like introductory chemistry or multimedia extension. In this case we gathered the data merging the different version under a single title.

The analysis of each single text, in terms of the general structure, started once this sample list of textbooks was completed. We gathered data based on the number of pages, chapters, images, length of chapters, and percentage of written text. Criteria and suggestions for evaluating Geosciences textbooks were taken from King (2010), Devetak, & Vogrinc, (2013), VV.AA, (2013).

The aim of the research was first to check how much space was given to each sub-discipline in the selected texts. A second aim was to compare texts which differed in font, graphics and editing style. We decided to use the number of characters per page as a unit of measurement, It should also be noted that pages differ quantitatively within texts. Therefore, for each one, a page-type was gathered with an average number of characters. Thus, it was possible to measure and compare the size of a single subject in different titles. It should be made clear that in this preliminary phase of the textbooks survey the aim was to check

the adherence of texts in relation to national curriculum guidelines and their general structure, not to evaluate the effectiveness of every single text.

### 2. The programme-evaluation survey.

In the Italian high school system, teachers are required to submit a report of their work to the School Director at the end of the academic year. This report summarises what has been achieved in class compared to what had been been scheduled at the beginning of year.

These programs are also used as reference by students who need to make up for their knowledge gaps in September, before starting the 2nd year. For this reason, a certain number of schools publish these evaluation reports openly on their websites. Therefore, we sampled the websites of the Italian Licei as a source of data.

It should be noted that, in 2010, the reform introduced two possible types of “Liceo scientifico” which schools could decide to run: the traditional “Liceo scientifico” and the “Liceo scientifico opzione scienze applicate”. Both types share the same guidelines for Geosciences but differ for the amount of time available to carry it out. Our study focused only on the first type of “liceo”. We considered the number of students enrolled at the first year course of “licei scientifici” in 2013, equals to 87551 (data from statistic service of MIUR -Ministero dell’Istruzione, dell’Università e della Ricerca- 2013/2014), and we figured 3243 probable first year classes for the “Licei scientifici” on the basis that, by law first year classes must have a minimum of 27 pupils (some classes may have exceeded this number). The number of reports (142) that were analysed from the first year, therefore, covers 4,38% of the selected national sample of “Licei scientifici”, and data was collected at random across the whole country while respecting the population percentage of each region.

Since there is no national standard format, all reports differ in terms of style, length, detail and outline. For this reason, we applied a uniform procedure for collecting and processing data. This was done by drawing a chart (fig. 2) which showed general benchmarks of all Earth and Space Science sub-discipline in the first column. Overall, the sequence of the arguments follows the one displayed by most texts. For each analysed programme we filled a chart: when a presented-issue matched a bench mark, a cell of the value’s column was filled with an x. For example, a statement such as “*H-R diagram*” matches a cell in ASTRONOMY/Star line, “*Karst landscape*” a cell in GEOMORPHOLOGY/Chemical weathering line (cfr fig. 2). When we found a generic reference to a main category, we marked the general category. At the end of this process, all data from the 142 programmes was merged in one combined chart, which produced the subsequent graph (see results, fig.9)

CHART FOR PROGRAMMES EVALUATION		
		<u>ATMOSPHERE</u>
<u>INTRODUCTORY SCIENCE</u>		Atmosphere's structure and composition
Attributes of geosciences		Winds
The scientific method		Meteorological events
Physical quantities and measurements		
Introductory chemistry		<u>CLIMATOLOGY</u>
introductory biology		Climate and weather
		Zones and climates
<u>THE OLISTIC SYSTEM PERSPECTIVE</u>		Climatic change on earth
Planet earth as a system		
System: classification and functioning		<u>GEOLOGY</u>
Earth's sub-systems		Mineral
		Rocks and rocks cycle
<u>ASTRONOMY</u>		Volcanism
Stars	X	Seismology
Galaxies		Structure of the earth
Solar system		Tectonics
Sun		Paleontology
Moon		Historical geology
Planet		
		<u>CARTOGRAPHY</u>
<u>MATHEMATICAL GEOGRAPHY</u>		
Geodesy		<u>GEO MORPHOLOGY</u>
Geographic coordinates		Physical weathering
Earth's motion and their effects		Chemical weathering
Calendars, time zone		Soils
		Earthflow
		Fluvial processes
		Glacial Processes
<u>IDROSPHERE</u>		Marine processes
water: chemical and physical properties		Aeolian processes
water cycle		Landscape evolution
Surface water flow		
Groundwater		<u>LANDSCAPE INTERPRETATION</u>
Glacier		Landscape's components
Seawater		Learning to read a landscape
Ocean currents		'Atlas' of Italian landscapes

Fig.2 – Chart for teacher's final report evaluation.

To sum up, source of data were:

- MIUR ([www.istruzione.it](http://www.istruzione.it)) e INDIRE ([www.indire.it](http://www.indire.it)): Regolamento (DPR 89/2010), allegati A-L
- AIE (Associazione Italiana Editori)
- School's web-site: 1) list of selected textbooks 2) teacher's annual report (6% of the national sample)
- Interviews: ANISN teachers (Associazione Nazionale Insegnanti Scienze Naturali), High school students, AIE data processors, Publisher's sale representatives.

## RESULTS

The results are grouped into three main categories:

1. Most selected Geosciences textbooks for first year high school students post 2010.
2. Comparison of the weight given to each sub-discipline in the textbooks.
3. Analysis of teachers' annual reports.

### 1. Most selected Geosciences textbooks for first year High School students post 2010.

The analysis of textbooks selected by teachers shows that twelve titles are representative of 94.54% of the sample under consideration, while the remaining 5.46% represents the sum of the other titles which, taken singularly, make up less than 1% of the whole sample (fig. 3 and 4). The textbook A (fig. 3 and 4) alone covers 45.94% of the sample among the list of 12 most selected texts reported above.

	<i>MOST SELECTED TITLES (first twelve)</i>	<i>FIRST AUTHOR</i>	<i>PUBLISHER</i>	<i>YEAR</i>
A	<i>OSSERVARE E CAPIRE LA TERRA</i>	LUPIA PALMIERI	ZANICHELLI	2011
B	<i>CORSO DI SCIENZE DELLA TERRA</i>	TARBUCK	LINX	2011
C	<i>SISTEMA TERRA</i>	CRIPPA	A.MONDADORI	2011
D	<i>DENTRO LE SCIENZE DELLA TERRA</i>	GAINOTTI	ZANICHELLI	2011
E	<i>TERRA E IL PAESAGGIO</i>	FANTINI	BOVOLENTA	2011
F	<i>SCIENZE DELLA TERRA</i>	PIGNOCCHINO	SEI	2011
G	<i>AMBIENTE TERRA</i>	MASINI	LINX	2011
H	<i>ELIO GAIA VULCANO</i>	CAMPANARO	LOESCHER	2011
I	<i>LA TERRA INTRODUZIONE</i>	RICCI LUCCHI	ZANICHELLI	2013
J	<i>CORSO DI SCIENZE DELLA TERRA</i>	ZULLINI	ATLAS	2011
K	<i>FONDAMENTI DI SCIENZE DELLA TERRA</i>	LONGHI	DE AGOSTINI	2011
L	<i>SCIENZE DELLA TERRA</i>	CAVALLONE	BULGARINI	2011
M	Σ REMAINING TEXTS (% ≤ 1,08)			2011

Fig. 3 – The twelve most selected texts in the chosen sample, in order of percentage by adoption.

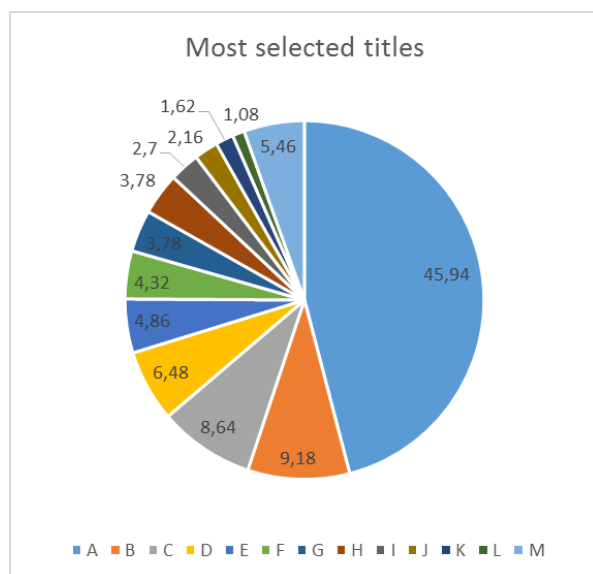


Fig.4 – Percentage of text adoption in the sample

## 2. Comparison of the weight given to each sub-discipline in the textbooks

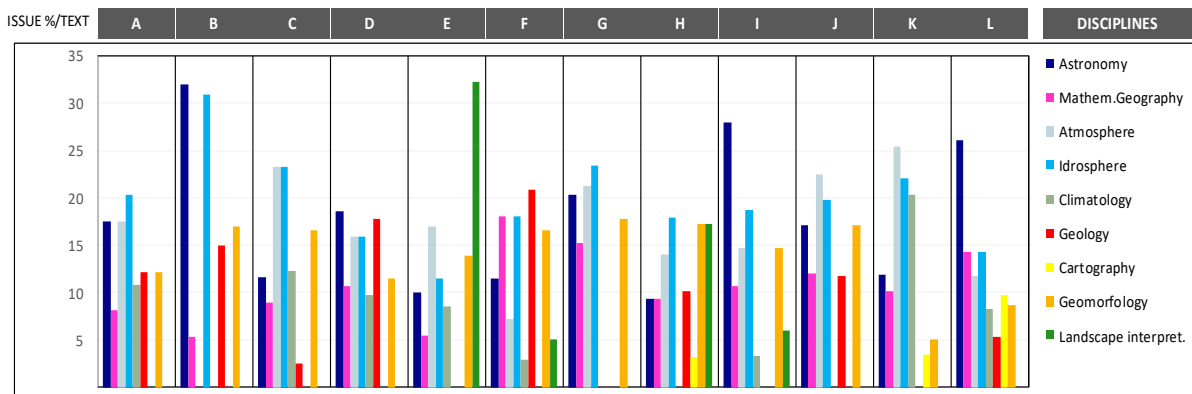


Fig. 5 – The relevant weightings of each sub-disciplines in texts: a comparative point of view.

The analysis of the texts' framework (fig. 5) reveals a certain homogeneity in terms of general structure: the majority of textbooks present all topics related to Earth and Space Science. The chapter sequence also follows, in most cases, a common pattern: astronomy, mathematical geography and physical geography. This last subject includes the study of the atmosphere and its dynamics, climate, hydrology (potamology, limnology, oceanology, and glaciology) and geomorphology. Typically, but not always, a chapter of geology is placed before geomorphology while simple concepts of pedology are arranged after the study of chemical weathering.

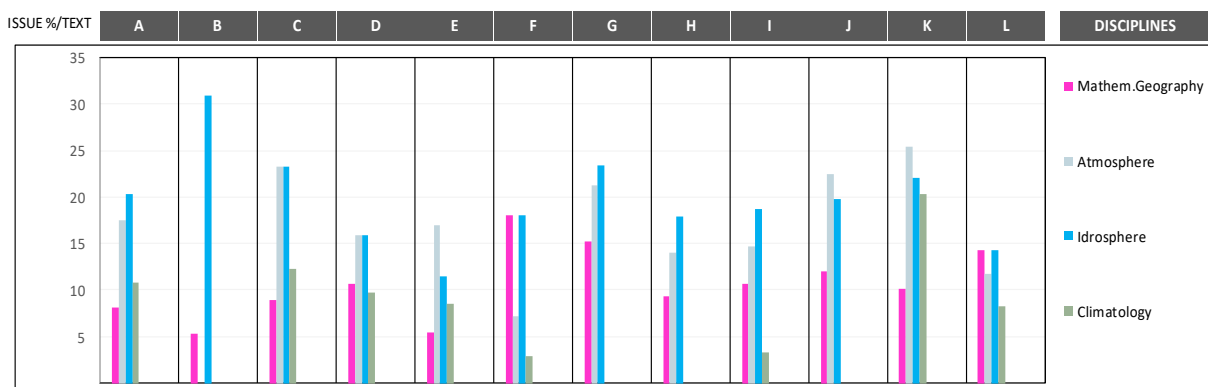


Fig6. – Mathematical geography compared with some physical geography issues in texts.

With reference to the first part of national guidelines, which concerns the study of Mathematical Geography and that of the major agents responsible for shaping the Earth's

surface, all the texts, shows a high degree of adherence. These topics are particularly developed in almost all the texts, covering between 40% and 70% of the total treated disciplines. (Fig6)

The same could be said about the space devoted to the relief-shaping processes and their products: Geomorphology occupies on average 14% of the volumes. (Fig.7)

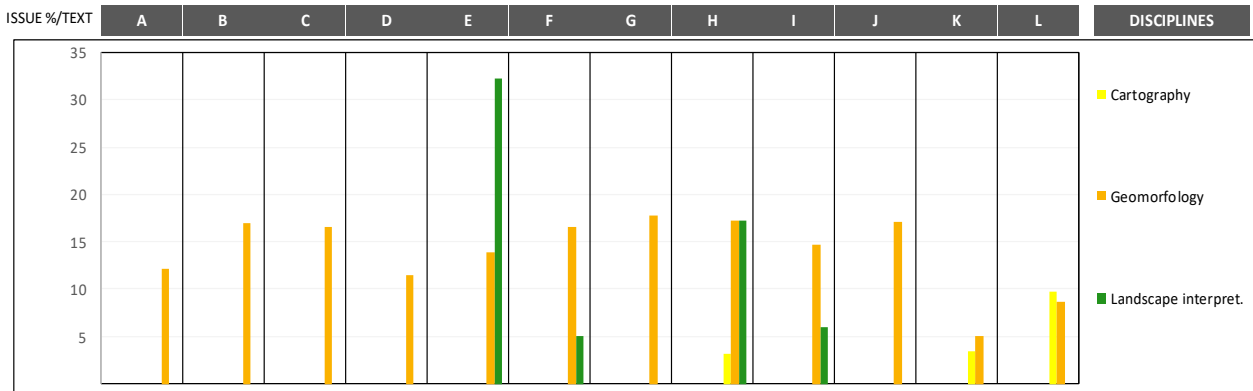


Fig.7 – Geomorphology, cartography and Landscape interpretation in texts. Here are presented together for their cross-curriculum potentiality with the geography syllabus.

Significant differences between the texts can be identified where they treat themes like cartography and landscape-interpretation which, more than others, represent a cross-curriculum opportunity with the geography syllabus (the second part of national curriculum recommendations). (Fig 7)

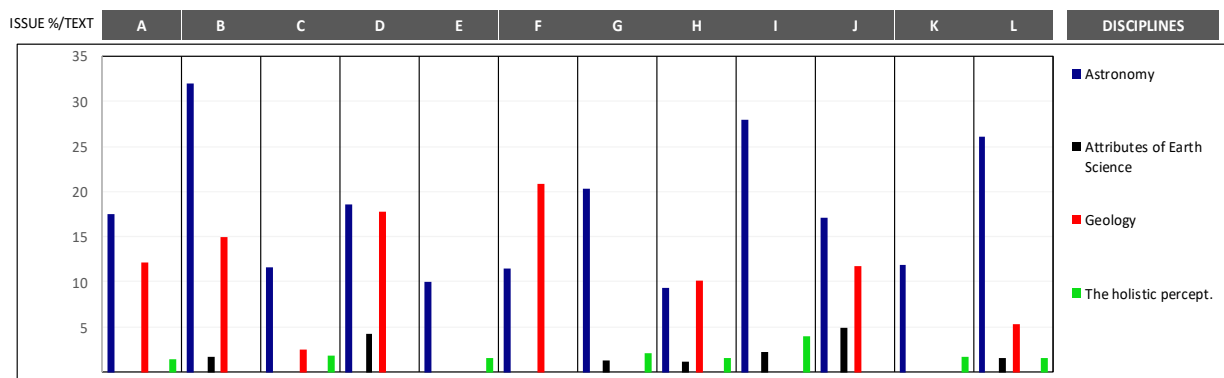


Fig.8 – Astronomy, Attributes of Geosciences, Geology and the holistic perspective in texts .

The results (fig. 8) also show how just over half of the texts (7/12) open with an epistemological chapter to explain the nature of Geosciences, their specific language and methodologies as well as their relationship with the other Natural Sciences. A slightly higher number of texts (8/12) add a few pages to the introduction, or a short chapter, to



present the systemic paradigm as a concept organizer according to recent trends in Geosciences teaching (Orion, 2007; King, 2008).

Finally, if we consider the presence of topics not strictly related to national guidelines for the first year, two facts emerge (fig. 8):

- All texts present a wide range of astronomy subjects including cosmology, planetology, astrophysics, absent in the national guidelines, with an average of 18%, but in three cases exceeding 25 % of volumes.
- Two-thirds of textbooks present articulated chapters on geology including volcanology, seismology and plate tectonics, which are the main topics of the last three years of the curriculum.

### 3. Analysis of teachers' annual reports.

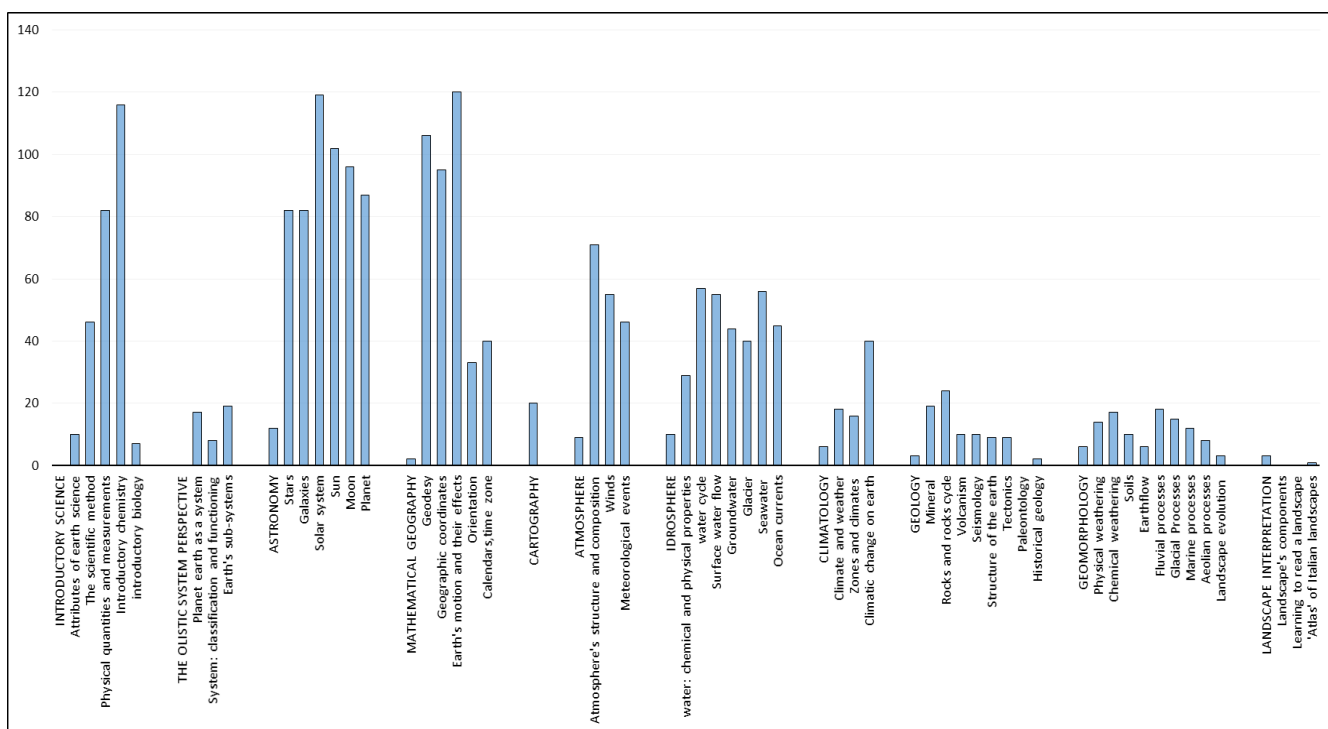


Fig 9. – Teacher's issues selection in final reports, school year 2013/2014.

The data obtained from the final report sample, presented by teachers at the end of the 2013/2014 school year, shows how there is a strong preference for selecting certain themes at the expense of others. In particular, as shown by graph 9 (fig. 9), most teachers tend to choose, for the greater part, chemistry, astronomy and mathematical geography. Less than half of the samples feature physical geography as part of the program and in

even lower percentages when the focus is on geomorphological issues, while the interpretation of landscapes is an almost absent topic.

It should be noted, however, that Geosciences could be also taught in the second year, even if national guidelines suggest that this part of the first biennium program should be preferably taught during the first year. As a result, some of our sample reports, which focused more on chemistry rather than developing topics of physical geography, could finish this part of the program at the beginning of the 2nd year.

## DISCUSSION AND CONCLUSIONS

The majority of selected textbooks offers a wider range of topics for the first year science course than those required by the reform for the first biennium (fig. 2). All twelve selected texts, for example, feature chapters on astronomy (fig.8), a topic which is not included in the reform's framework. In a few of these textbooks there are also chapters dedicated to volcanism and earthquakes, that are scheduled for third and fourth years. These results reveal how books presenting a broad range of subjects are selected even though there is insufficient time to cover all of the topics (2h/week in the biennium). Many authors (Tosetto, 2011; Marini *et al.*, 2012) have underlined how a lack of time to teach all aspects of the science programme is one of the critical issues to have emerged as a result of the reform. This more ample variety of topics, however, allows teachers greater freedom of choice when scheduling and teachers seem to reward more this aspect than giving more space to the supporting concepts of physical geography as suggested by the national guidelines. Although it is true that an "encyclopaedic" structure can offer a descriptive framework for the geosciences, at the same time it may hinder the ability to identify of the main idea behind the text even when a holistic perspective functions as a building tool (fig. 8).

If we exclusively take into consideration the space in the texts devoted to cartography and landscape interpretation, only a small number of textbooks would be able to implement the reform's recommendations (fig. 7). The absence of a unifying supporting concept, as can be noted from the structure of the text (which could be, for example, the landscape as a systemic resultant), makes it difficult for students to organize ideas and concepts into a coherent mental framework. As a result, there is a serious risk that, despite the high quality of texts and annexed images, the suggested topics could appear as a

fragmented body of contents, especially to the eyes of poorly prepared first-year students.

It is also worth pointing out that a very small number of textbooks (fig. 8) opens with an epistemological introduction which describes the nature of Geosciences distinctive field of study and introduce the roles and competence areas of mathematical and physical geography. Overcoming these obstacles, therefore, becomes the task of the teacher who will use the textbook exclusively as supporting tool for student and not as a reference on how to structure the course.

The fact that there is no explicit guiding idea based on physical geography's supporting concepts, which emerged from the text survey, has also been confirmed by the results of the analysis of the teacher's final reports (fig. 4). This lack of a guiding idea is evident by the fact that topics are presented, if not in a fragmented way, then often based on a purely descriptive approach, rarely connectively linked. Most of the reports indicate that a significant part of the program is allocated to astronomy (not included in the reform's framework) and, in accordance with the national guidelines, mathematical geography (i.e. the study of the motions of the Earth).

Even though the descriptive study of freshwater and the structure of atmosphere are topics treated with significant frequency, only in a small number of cases these elements are covered as shapers of the Earth's surface. Geomorphology often seems to be either absent or only occupying a very small part of the program.

Overall, the analysis of the reports shows that only a minority of teachers follows, or partially follows, the national guidelines as a model for programming.

This may be the result of several factors, which can also act concurrently:

The new reform has not been adequately thought out and neither has it been effectively implemented, even though it introduces new positive elements to encourage an integrated learning of different subjects, such as the inclusion of Geosciences in the first-year and vertical scheduling in parallel with chemistry and biology.

Teachers tend to follow programs they are already well-acquainted with. For example, they choose to start with astronomy, a strong topic in Earth and Space Sciences which, prior to the reform, was taught during the last year of the "licei". This programming choice is the result of the lack of information in the new reform regarding the didactic aims and the unclear guidelines concerning their realisation (limited to a table of contents). More detailed indications would be useful for the teachers when devising their programs.

The above factors could also account for the fact that a considerable number of publishers, in this transitional phase, are publishing textbooks without a well-defined interpretive approach to the subject in order to meet the demands of the market.

Under the new reform, there is not enough time to go through the Geosciences program during the first year as the chemistry program has to be taught simultaneously during the two hours per week classes (Tosetto 2011, Marini *et al.*, 2012).

Teachers are finding it hard to adapt their work to the demands laid out by the reform. The difficulties of implementing change in the educational context is highlighted by many international studies (Davis, 2003; Fink & Stoll, 2005). The high average age of Italian teachers, which means teaching paradigms remain unchanged in time, could be one of the underlying factors. Recent research by the European Commission on education shows that the average age of teachers in Italy is the highest in Europe, with nearly 60% of them aged over 50 (Eurydice Report, 2013).

The majority of teachers in Italy have a biology background (King, 2008). This could represent an obstacle when teaching disciplines that required specific skills such as geosciences methodologies, geoscientific spatial abilities and geoscientific fieldwork methods and attributes. These are all skills that contribute in making Geosciences distinctive teaching curriculum subject (King, 2008).

In conclusion, our study seems to reveal that geosciences has a minor influence on the way general science is taught at high school level in Italy.

We believe, however, that the educational value of learning Geosciences goes well beyond strictly disciplinary and informational goals, since it aids the development of student's skills extending further the field of sciences (i.e. spatial-temporal cognitive abilities). In addition, these same goals acquire value in a collective sense over and above individual acquisition. In a country like Italy, whose fragile hydro-geological balance is increasingly endangered by climate change, the development of a capable and responsible citizenship with regard of the themes of Geosciences is an essential component in the framework of a reformed educational system.

We believe the reform even with its lack of information could represent a challenge for Italian science teachers, given the importance that Geosciences are acquiring in many reformed educational curricula where the geosciences have been identified as distinctive subject (King, 2008).

In the meantime, several strategies could be implemented to improve the current situation:

Firstly, the national guidelines regarding the teaching of Geosciences should be revised by the curriculum-planners of MIUR (Ministero dell'Istruzione, dell'Università e della Ricerca). There should be a more detailed definition of the learning goals and the subsequent selection and chronological order of the topics, including clear indications of how, and when, these can be integrated with the biology and chemistry courses. With this in mind, it is evident that the teaching guidelines for Geosciences to be found in the Brocca reform project, from the early 90s, still represent a valid model (VV.AA., 1991).

Secondly, there should be a government investment of resources in teacher training, both pre-service and in-service, regarding the implementation of the new curriculum within the context of the reformed "licei".

In conclusion, when we take into consideration the various aspects of teaching physical geography in Italian high school, it is clear that further research should be undertaken to better understand the mechanisms that hinder the effective teaching of this subject.

## ACKNOWLEDGMENTS

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4.

## STARTING HIGH SCHOOL: STUDENTS' POINT OF VIEW ON GEOSCIENCES

- *Sturani M., Mammola S., Pelfini M., (in preparation) Student 's Geosciences awareness at the beginning of Upper Secondary School in Italy: a case study on the impact of in and out of the class experiences, to be submitted to the International Journal of Science Education*

# **Student's Geosciences awareness at the beginning of Upper Secondary School in Italy: a case study on the impact of in and out of the class experiences(\*)).**

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## **ABSTRACT**

*The Italian scholastic system has been recently reformed, with relevant innovations especially in the domain of the Geoscience. In particular, their study is introduced for the first time at the beginning of the High-school—so-called “Lyceum”. In light of this novelty, we conducted a research study aimed to evaluate the attitude towards Geoscience that Italian students have matured in the transition from lower to upper secondary school. A questionnaire survey was addressed to students belonging to six different High-schools in Northwest Italy. The questionnaire aimed to unveil the students' educational background on a number of Geoscience topics, their parental education and the frequency by which they undertake outdoor activities. These data were analysed by means of graphical devices and multinomial logistic regressions. Our data suggest that lower secondary school exposure to Geoscience promotes in students a great interest in the subject area, as well as a comfort level in the subject at the entrance to the Lyceum. According to the students' answers, the school environment proved to be the predominant source of their Geoscience education, rather than internet and other media. Regression analysis also pointed out that students have a higher probability of having a high awareness on Geoscience if they frequently undertake outdoor activities, and more so if entities supervising them in such activities possess a high educational attainment. In this respect, family emerged as the main actor getting students outdoor, whereas the school was almost very little involved in such field activities. We show that the outdoor learning has a direct and beneficial influence on students' cultural background and can potentially influence their Geoscience awareness and environmental concern. To optimize Geoscience teaching in Italy, we thus suggest that a change of our didactic paradigm is in order, with an implementation of field activities in the teaching practice.*

(\*) The present text could show some differences in the published version as the final manuscript is still in preparation.

## INTRODUCTION

In 2010, the Italian government unveiled new teaching guidelines for the upper secondary educational system (Decreto Interministeriale 211, 7 Oct 2010, Gazz. Uff. 14 Dec 2010, n. 291). The reform brought significant changes in the domain of science teaching, especially in the national high-school known as "*Lyceum*"—school specifically tailored to prepare university access. In this type of institution, a relevant innovation of the reform regards Geoscience, the study of which is introduced for the first time at the beginning student career lasting five years (Tab. 1). Prior to this reform, Geosciences were taught exclusively in the fifth year together with Space Science.

•*Tab. 1* – The scheme shows the framework of Geosciences key contents through the whole five years' course as indicate in 2010 national curriculum (Decreto Interministeriale 211, 7 Oct 2010, Gazz. Uff. 14 Dec 2010, n. 291). (\*) Time table refers to general science course of which only a fraction is dedicated to Geosciences topics—the remaining portion covers chemistry and biology.

2010 – GEOSCIENCES CURRICULUM' KEY CONTENTS FOR REFORMED <i>LYCEUM</i>	
1st/2nd years science course (mainly in the 1st year)  2h lessons/week*	<ul style="list-style-type: none"> <li>• Earth's motions and their implications</li> <li>• Geomorphology</li> </ul>
3rd/4th years science course  3h lessons/week*	<ul style="list-style-type: none"> <li>• Minerals and rocks</li> <li>• Volcanoes and earthquakes</li> <li>• Geodynamic of Earth surface</li> </ul>
5th year science course  3h lessons/week*	<ul style="list-style-type: none"> <li>• Meteorology</li> <li>• Plate tectonics</li> <li>• Further explorations of previously treated arguments</li> </ul>

In 2012, the reform framework was further integrated with the guidelines for lower secondary school (Tab. 2)

Tab. 2– Geosciences specific learning goals as indicate by national guidelines at the end of lower secondary school, 13 years old students. (Indicazioni nazionali per il curricolo della scuola dell’infanzia e del primo ciclo d’istruzione, MIUR, Settembre 2012)

2012 - GEOSCIENCES SPECIFIC LEARNING GOALS FOR STUDENTS AT THE END OF LOWER SECONDARY SCHOOL.
- Being able to identify—by means of practical and outdoor activities—the principal type of rocks and the lithogenetic process which originated them
- Being able to describe the internal structure of Earth and its internal motions—basics of plate tectonics.
Being able to identify seismic, volcanic and hydro-geological risk of the proper region.
- Being able to take part to practical experience involving collection of rocks and its analysis.

Given these important novelties, an evaluation of the interest, motivation and attitude towards Geoscience that Italian students have matured in the transition from lower to upper secondary school seems to be in order. We are convinced that a particular focus should be given to evaluate the attitude of students towards the main Geoscience topics of first year class programme for *Lyceum* introduced by the reform (Tab. 1).

Although the Italian reformed context may seem to be an isolated case, and thus of little interest in an international educational panorama, it is worth remembering that “[...] *geoscience education is gaining increasing prominence within school science education in a number of countries worldwide*” (King, 2008, p. 187; see also King, 2013). In addition, Geoscience is among the evaluation subjects of the most known international education system assessment programmes such as TIMSS (Trends in mathematics and science) and PISA (Programme for International student assessment), which involve Italian students as well. These two assessment programmes differ not only for the age groups of the targeted learners (13 and 15 years old, respectively), but also for the kind of skills and knowledges they test. Specifically, TIMSS evaluate students’ achievement in relation to mathematics and science curricula, while PISA focuses on the application of knowledge to "real-world" situation (see Wu, 2010 for an in-depth analysis).

However, even if these two assessments test the level of science curriculum achievement or the competence in using some Geoscience knowledges, they do not tell us much about students' interest, motivation and attitude towards Geoscience itself.

The investigation of students' attitude towards studying Science and Technology at high school level have been a very common subject of work in the last decades as reported by Osborne et al. (2003) and Potvin & Hasni (2014). However, specific studies aimed at assessing the attitude toward Geoscience for UK and US realities are as yet very few (Hetherington 2010, Betzner & Marek 2014). Specifically, Hetherington (2010) focused on the difference of attitude by student gender, whereas Betzner & Marek (2014) investigated the difference of attitude between teachers and students. With respect to the Italian context, although a couple of researcher have investigated the effects of reform on Earth science teaching (Tosetto, 2010; Marini et al., 2012), there are no specific works on the matter.

So, whilst the reform guidelines (Decreto Ministeriale n°254, 16 Nov 2012) indicate the standards of geoscience competences and knowledges that the student is supposed to gain at the end of his first educational cycle (K-13) (Fig. 2), until now no report give us an idea of the comfort level and attitude they have reached in the subject area.

Also, for what concerns the influence of general outdoor activities on Geoscience attitude at K-13 level, very little is known.

As far as we are aware, the few research in this topic are a number of studies on the factors influencing US students' choice for Geosciences major and careers. In this case, authors found that, while growing up, frequent outdoor experiences—family camping trips, road trips to national parks, etc.—and the practice of collecting rocks and minerals during childhood, are among the factors influencing the most the student future attitude towards Geoscience (e.g., Levine et al, 2007; Stokes et al., 2015).

### *Purpose of the Study*

In the last five years, Italian secondary school students have been requested to comply with new national guidelines for Geoscience. We are convinced that after this five-year trial, the time is right to trace a balance and evaluate the effect of the reform on the general student's attitude toward the subject. In order to achieve this goal, we carried out a questionnaire survey addressed to a sample of 1<sup>st</sup> year high-school students of north-western Italy, aiming to shed light on:

- the background on Geoscience topics possessed by 1<sup>st</sup> year students;

- the degree of interest that students show towards a selection of the Geoscience topics scheduled for 1<sup>st</sup> year science *Lyceum* curriculum;
- the students' comfort level toward the Geoscience topics mentioned above;
- the different source of Geoscience education, other than school, exploited by students;
- the teaching methods that have mostly influenced the learning process of Geosciences during lower secondary school, from the student's point of view;
- the influence of general outdoor activities on students' attitude toward Geoscience.

Specifically, we hypothesize that a frequent practice of outdoor activities positively influence the Geoscience awareness matured by students, intended as the level of attitude and comfort level in the subject attained.

## METHODS

A questionnaire survey was designed with closed-ended/ordinal-scale questions to assess the objectives presented above. A first set of questions was designed to verify the general students' educational background and the level of interest towards a selection of Geoscience topics which they will face during the 1<sup>st</sup> year of *Lyceum* scientific curriculum; then, to investigate how well they feel prepared in the domain of Geoscience and which had been the main sources of education for it.

A second set of questions aims to investigate the level of parental education, the frequency of student' outdoor activities—mainly recreational activities such as cycling, hiking, climbing or camping in natural settings—and who accompanied them in these outdoor activities. In this case, the sample data were used for inferential statistics.

In 2015, the questionnaires was given to a first pilot sample of 118 students belonging to 5 classes and three different High schools, namely Liceo Scientifico statale Giordano Bruno (Turin), Liceo Scientifico statale Augusto Monti (Chieri) and Liceo Scientifico statale Norberto Rosa (Bussoleno). In 2016, an on-line version of the questionnaire designed to provide the baseline for regression-type analysis was further implemented, and was given to a second sample of 151 students (8 classes) belonging to other different High schools, namely Liceo Scientifico/Linguistico statale Nicolò Copernico (Torino), Liceo Scientifico statale Piero Gobetti (Torino), Liceo Classico/linguistico Vincenzo Gioberti (Torino). All the institutions from which the students were sampled are in the metropolitan area of Turin and relative Province, NW-Italy.

### *Regression analysis*

In order to verify our working hypothesis, we performed a multinomial logistic regression as implemented in the *nnet* package (Venables & Ripley, 2002) in R (R core team, 2015). We expressed the frequency of outdoor activities as a three-levels categorical variable (levels: "Never", "Holiday", "Often"). We selected the student gender (level: "Male", "Female") and the educational attainment of the father and the mother (levels: "Low", "High") as additional categorical covariates. Furthermore, we set up one continuous variable—Geoscience awareness—representing a *proxy* of the familiarity of the student with general geoscience topics. To construct this variable, we assigned a score from 1 to 4 to each answer the students gave regarding their familiarity with eighteen topics related to geosciences, and summed up each value obtaining a final Geoscience awareness score ranging from 18 to 72.

Prior to model fitting, we explored the dataset following the standard protocol for data exploration proposed by Zuur et al. (2010). According to Zuur et al. (2010), the inclusion of outliers and highly correlated predictors in the regression analysis leads to misleading results—type I and II statistical errors. Thus, we used Cleveland's dotplots to assess the presence of outliers in the continuous variable, and we constructed standard box-plots to graphically evaluate collinearity between the continuous and the categorical covariates. Conversely, assessing collinearity among categorical covariates is more complicated (e.g. Kupper et al., 1983) and, as far as we are aware, no general silver-bullet for handling such collinearity has been put forward in literature. Here, we highlighted potential collinearity among categorical variables via the *table* R command.

We fitted an initial model including all covariates of interest, in which we also allowed for potential interaction between the continuous and the categorical covariates. Once we fitted the initial model, we applied a backward model selection (Johnson & Omland, 2004), whereby we obtained a simplification of the initial model by sequentially deleting terms according to AICc values (Hurvich & Tsai, 1989; Burnham & Anderson, 2002). We reiterated the procedure, until a Minimum Adequate Model of fixed effects remained. The outcome of the model consisted of regression coefficients for the explanatory variables, whose significance was assessed via z-test.

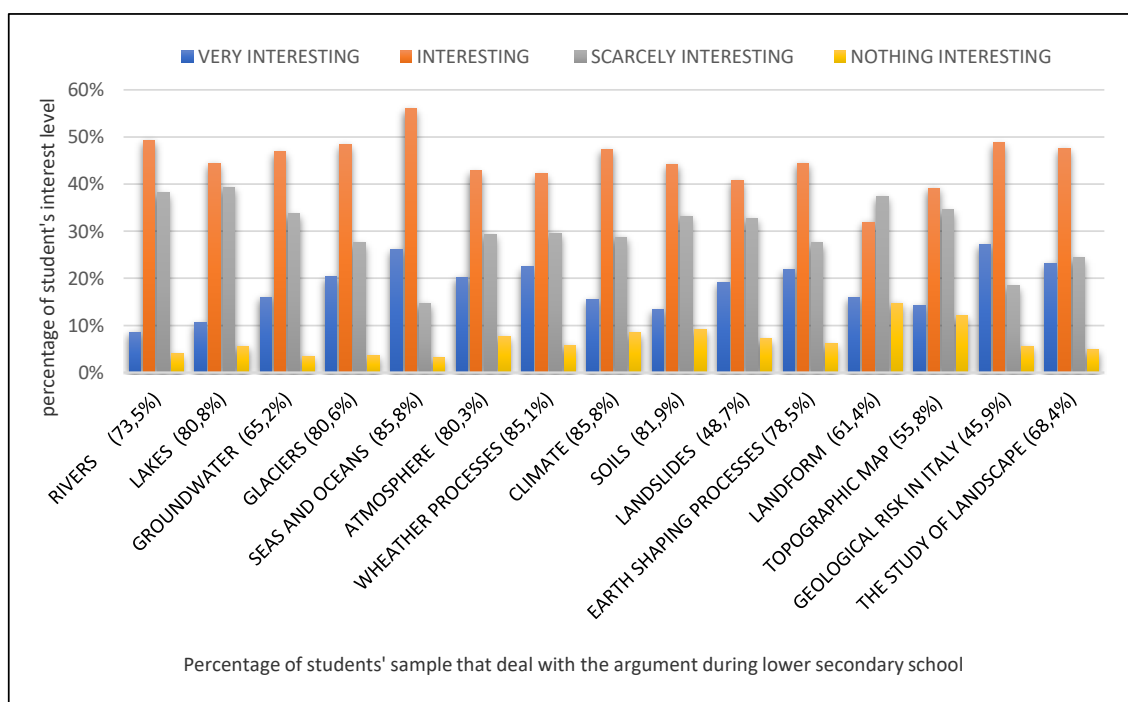
## RESULTS

### *Students' educational background*

The first section of questions examines students' educational background. In other words,

students were asked to list which Geosciences topics they have treated prior to enter High school. Results shows that almost all the Geosciences topics scheduled for the first year of *Lyceum* have been previously faced by the large majority of students (more than 70 % on average). Our data also reveal that the prior exposure to Geosciences promoted a positive interest in this subject area in a wide group of tested people (Fig. 1).

Fig.1 Beside the topics is shown the percentage of student's sample which had faced them during lower secondary school. Then for each one is shown the levels of interest raised.



### *Comfort level on Geosciences topics at the entrance of Lyceum*

This section of questions examines students' comfort level on several Geosciences topics at the entrance of High School. Our data reveal a generally high level of comfort in the subject of Geosciences, with the exceptions of two topics: Geotourism and Geosites (Fig.2).



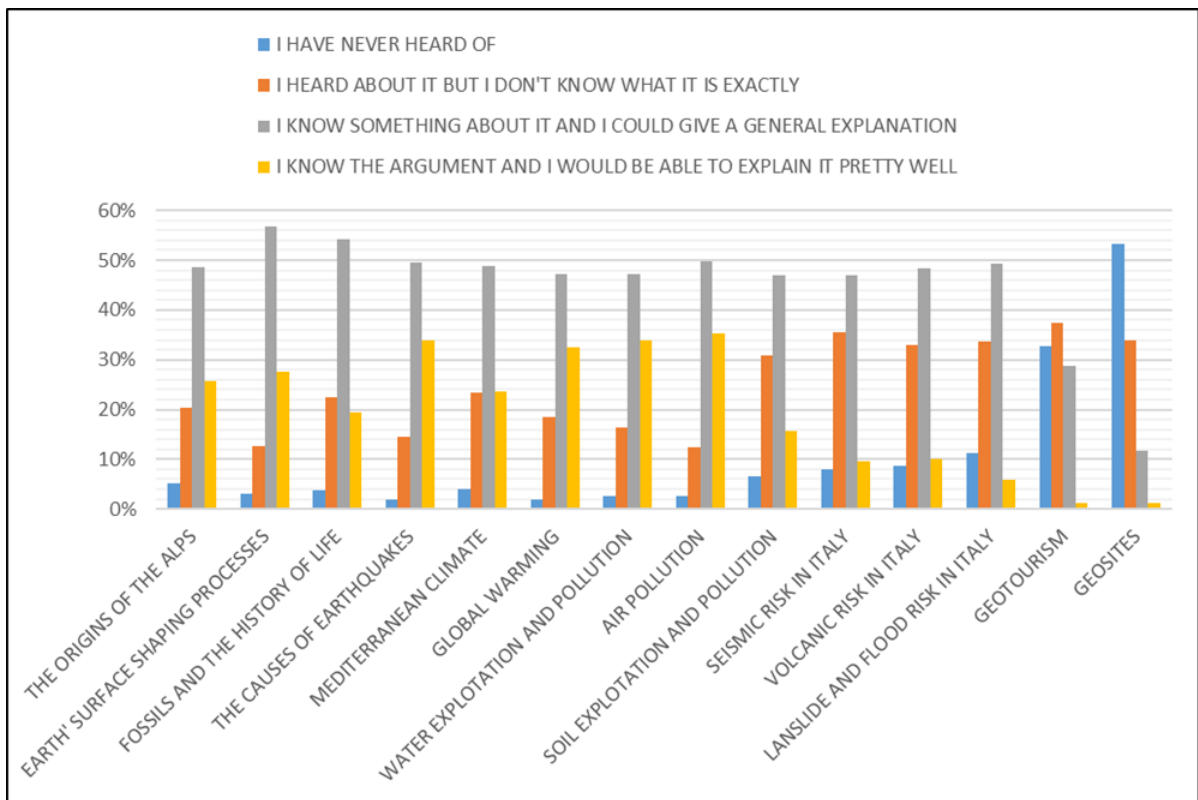


Fig.2 Level of student's comfort toward a selection of Geosciences topics.

### *Geosciences educational sources*

By relying on the same topics used to test the student' geoscience knowledge at the beginning of "Liceo", we further asked student to identify their main education sources. Students were allowed to choose between School, Family, Friends, Traditional Media and New Media. As expected, school proved to be the main source of student's education with respect to most of the topics investigated (Fig. 3). Conversely, the *Classic Media* (Tv, Radio, Newspapers and Magazines) proved to play an important, yet secondarily role in several Geoscience education topics—but see specialized topics such as alpine orogenesis, earthquakes, earth surface shaping processes, fossil and history of life, and Mediterranean climate (Fig. 3).

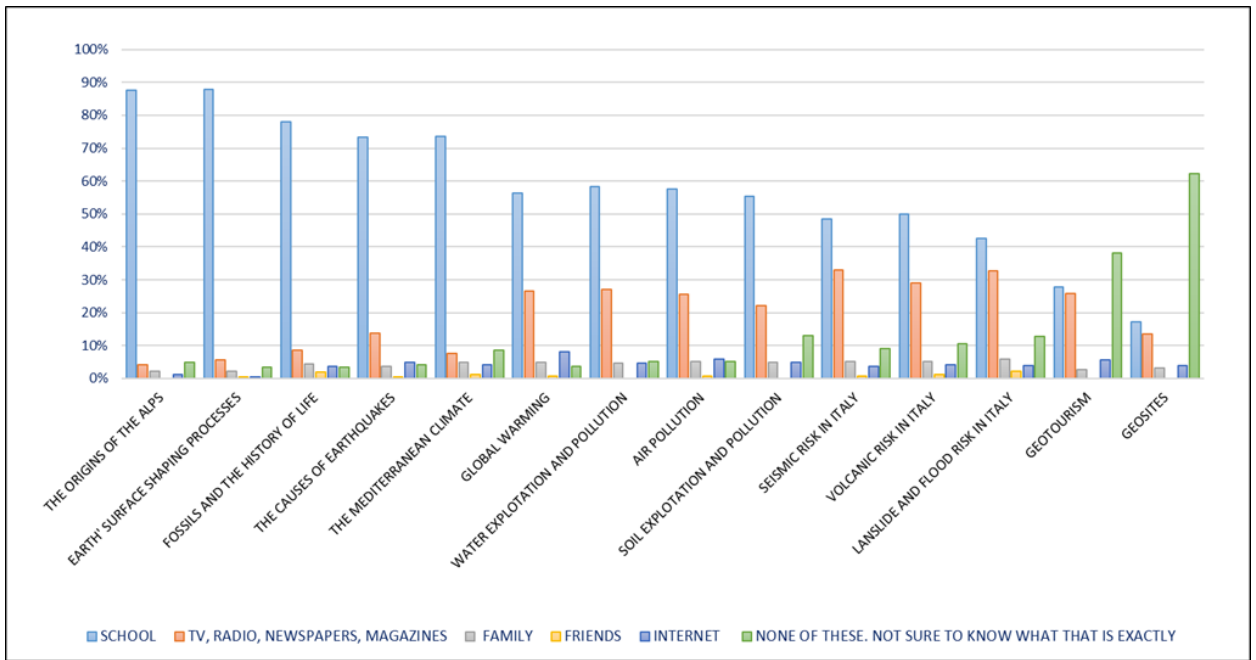


Fig. 3 The role of different sources of information in Geosciences educational process

### Preferred didactic methods in Geosciences

Students were asked which didactic methods they prefer in learning Geosciences. *Practice work* and *Outdoor activities* emerged as the preferred didactic options while the *Interpretation of maps* and the *Study from books* the less ones (Fig. 4).

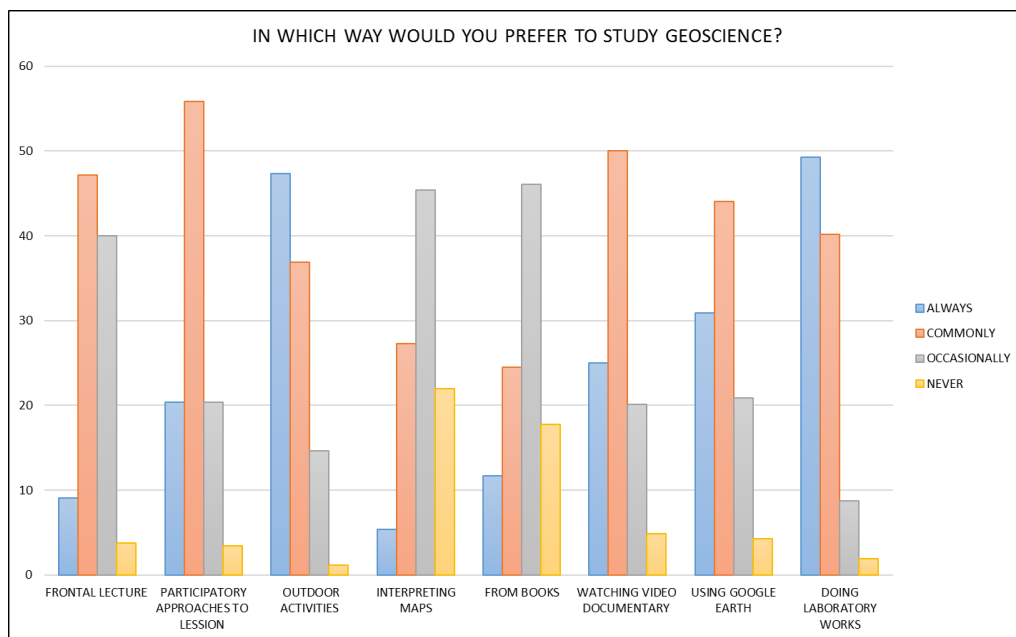


Fig.4. Students' preference in Geosciences learning methods.

### *Who get students experiencing the outdoor?*

Students were asked to identify who primarily get them to experience outdoors.

Data presented in fig. 7 indicate that the family is the primary figure accompanying students in their outdoor experiences (66%), followed by friends (23%). Conversely, school contributed only 3% in getting students outdoor.

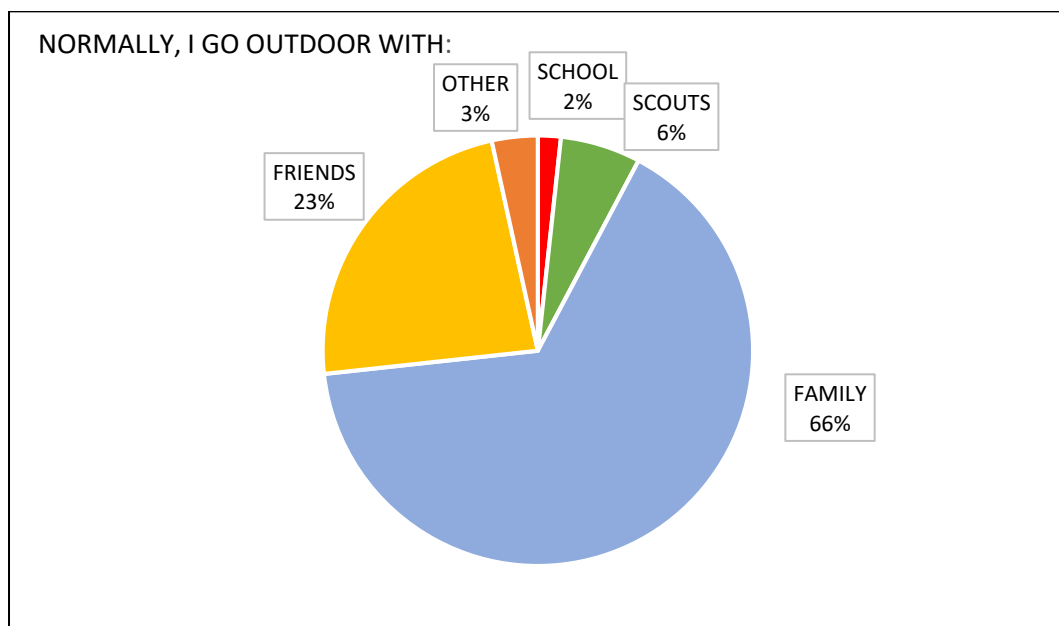


Fig. 5. Pie chart of the percentage of entities accompanying students outdoor.

### *Regression analysis*

In light of the data exploration (Zuur et al., 2010) the variable educational attainment of the mother was dropped from the analysis, being collinear with the educational attainment of the father. The model selection procedure based on AICc values indicated the following as the most appropriate model structure supported by the observations (R notation, the asterisk denote an interaction):

Frequency of outdoor activities ~ Geological awareness \* educational attainment (father)

There was a significant increase in the probability of having an high geological awareness at increasing levels of outdoor activities relative to the reference category "Never" (Holiday Estimate  $\beta \pm s.e. = 0.55 \pm 0.17$ ,  $p=0.002$ ; Often Estimate  $\beta \pm s.e. = 0.85 \pm 0.05$ ,  $p<0.001$ ). The probability of having a father with an high educational attainment was higher at increasing levels of outdoor activities relative to the reference category (Holiday Estimate  $\beta \pm s.e. =$

17.78±7.36,  $p=0.015$ ; Often Estimate  $\beta \pm \text{s.e.} = 29.57 \pm 5.11$ ,  $p < 0.001$ ). There was a significant interaction between the geological awareness and the educational attainment of the father at both level of outdoor activities (Holiday Estimate  $\beta \pm \text{s.e.} = -0.18 \pm 0.76$ ,  $p=0.01$ ; Often Estimate  $\beta \pm \text{s.e.} = -0.62 \pm 0.05$ ,  $p < 0.01$ ) relative to the reference category. The effect of this interaction can be visualized in Figure 6.

On the contrary, the effect of the gender was not significant (Holiday Estimate  $\beta \pm \text{s.e.} = -0.18 \pm 0.76$ ,  $p=0.80$ ; Often Estimate  $\beta \pm \text{s.e.} = 0.92 \pm 0.85$ ,  $p=0.27$ ), and therefore this variable was dropped from the model during the backward elimination.

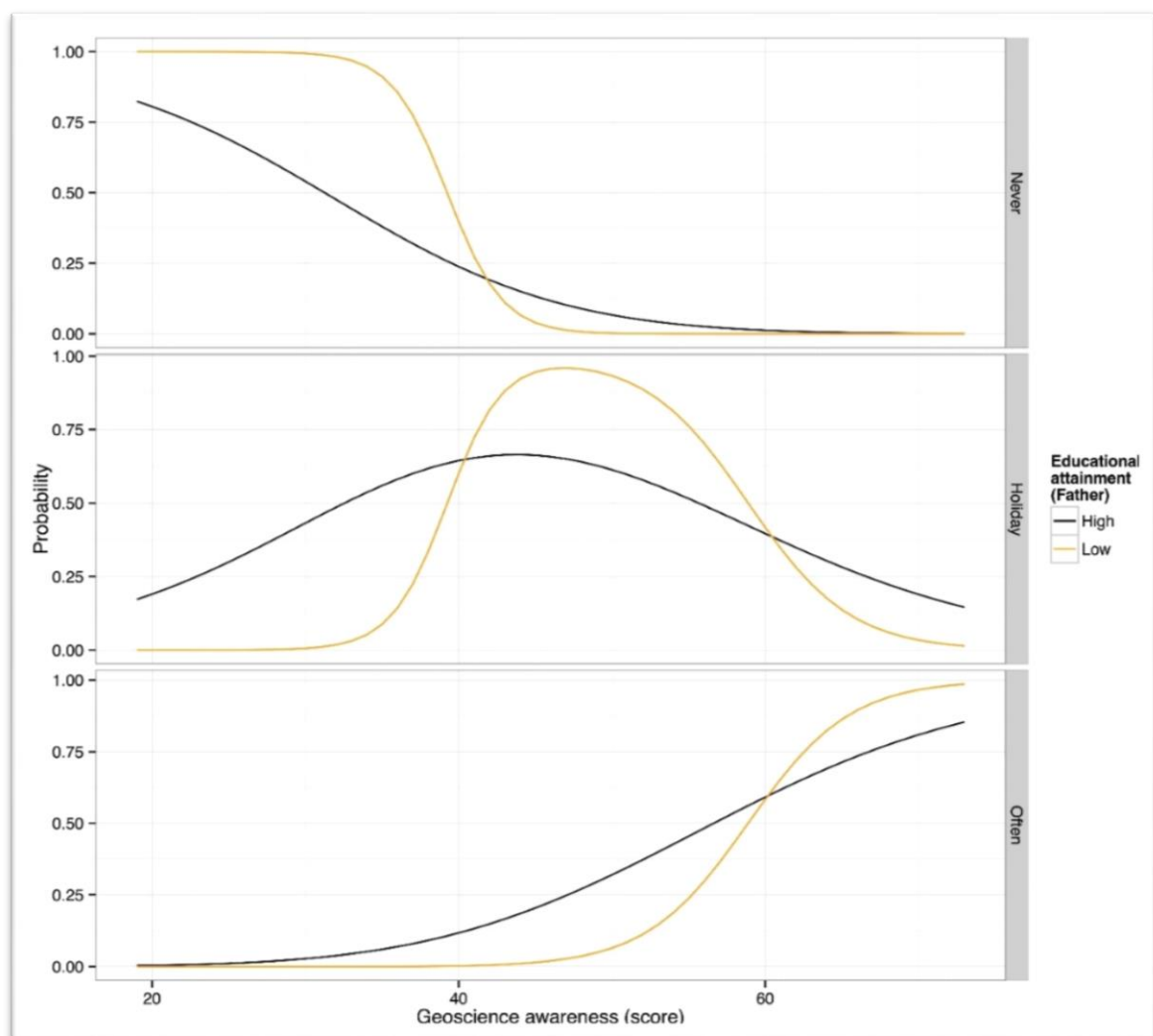


Figure 6. Predicted probability of the effect of the frequency of outdoor activities and the educational attainment of the father on the student geological awareness derived from the multinomial regression analysis. Each panel represent the predicted probabilities at different frequency of outdoor activities —top panel: none or sporadic outdoor activities (level “Never”); middle panel: outdoor activities preferentially during summertime holidays (level “Summer”); bottom panel: one or more days of outdoor activities each month (level “Often”). For

each panel, the two lines indicate the predicted probability depending on the educational attainment of the student's father—orange lines: low educational attainment; black lines: high education attainment.

## Discussion and conclusion

There exists a growing trend for science teaching systems alike to invest less efforts to offer students outdoors and practical activities. Increasing costs, health and safety regulations, logistic and bureaucratic limitations and teachers' lack of experience, has been highlighted as the main factors demotivating the planning of field activities (Orion, 2003; Tretinjak & Riggs, 2008). In addition, the time that young generations spend playing outdoor has shrunk dramatically due to the lack of safe greenspace in cities and the time they spend on screens (e.g., smartphone, tablet...).

Evidence suggests that the lack of outdoor experiences could influence students in a wide range of effects. It may affect student academic performance (Lieberman & Hoody, 1998), promote feelings of disconnect from and dislike of environments (Bixler et al., 1994) and more in general influence attention and motor capacities.

In parallel with this, Geoscience learning —with its need of field activities —is gaining a new light in the Italian educational reformed context.

Our research was specifically designed to foster our understanding on these two realities, using the Italian high-school system as a test case. Relying on a homogenous sample of questionnaires addressed to high-school students, we were able to highlight some general trends in Geoscience teaching and learning, in light of the newly reformed system.

The first set of results (see Figs 1 and 2) suggest that the sampled Italian students possess an adequate level of confidence towards Geoscience arguments at the entrance of High school. In other words, they declare to have a solid background in a number of Geoscience topics, thus displaying the requested attitude to deal with the more advanced topics which will be tackled during the High-school career curricula. These data are in line with the TIMSS 2015 results for Geoscience content knowledges, attesting that Italian students are among the average performance of participating countries. To a noteworthy extent, there is also a positive trend with respect to the last two editions of evaluation, which took place in 2009 and 2011 (AAVV, 2016).

This intellectual capital is very important and it is crucial that teachers recognize and valorise it while scheduling the curriculum for the 1st year of *Lyceum*. However, in a previous study, it

has been shown that only a small percentage of Italian teachers comply with their 1<sup>st</sup> year Geoscience teaching schedule (Sturani, 2016).

On the other hand, our data suggest that the secondary level students still perceive the school environment as the predominant source of Geoscience education, its role being higher than that of traditional Media and much higher than that of other sources such as the family and friends (Fig. 3). This result also reveals that Italian families, in general, possess a very poor geological awareness.

In parallel, students seem to have a very clear opinion regarding their preferred didactic methods for learning Geoscience. Specifically, their answer to our questionnaires indicated a clear preference for practical and in-field activities, rather than the frontal lectures and other traditional didactic methods such as map interpretations (Fig. 4). In line with this result, the importance of an in-field didactic approach has been long time recognized as a crucial, if not unavoidable step in the process of Geoscience learning at secondary school level (Orion, 1989, 1993, 2003; Marques & Praia, 2009; Mogk & Goodwin, 2012).

In this regard, the point of view of the students clearly diverges from that of their teachers, since school figures at the last place for promoting their outdoor practices (Fig. 5). Moreover, active didactics still remain a rare exercise in the Italian teaching context (AAVV, 2003).

Our regression analysis also showed how general outdoor activities have a significant and positive impact on the general Geoscience awareness of students. These results are compelling, because they testify that the process of learning directly in the field—e.g., by observing and interpreting the environment—has a direct and beneficial influence on students' cultural background and has the potential to “[...] influence [their] environmental career choices and environmental concern” (Strife & Downey, 2011: p. 10).

However, this analysis highlights an additional important point: a higher geological awareness is not only the result of the outdoor practice *per se*, but also of the interaction between such activities and the presence of a supervisor possessing an adequate educational background to support the learning process—in our case, see the significant effect of the attainment of the father (Fig. 6) and the parallel role of the family in getting students outdoors (Fig. 5). This is because an attained supervisor will be able to actively influence the learning process, supporting student observation of the field with its explanations, thus channelling the in-field observation into meaningful knowledge.

The scholastic systems, by offering more and more outdoor activities to their students, has the potential of fulfil this twofold task. Indeed, it can offer out of the class activities meanwhile maximizing their educational potential—in fact, as discussed before, the school environment is perceived by students as the predominant source of their Geoscience education (Fig. 3). Altogether these data, even considering the small size of the sample, seem to indicate that, to optimize Geoscience teaching in Italy, a change of our didactic paradigm is in order.

### Acknowledgments

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## 5.

### PRE-SERVICE SCIENCE TEACHERS FACING THE NEW NATIONAL STANDARDS FOR GEOSCIENCES TEACHING AT SECONDARY LEVEL.

- *STURANI M., PARRAVICINI P., PELFINI M., (accepted with revision). Pre-Service Teachers attitudes in planning and scheduling geofield trip at secondary level: a case study, Rendiconti Online Della Società Geologica Italiana\* .*
  
- *PELFINI M. , BOLLATI I. , GIUDICI M., PEDRAZZINI T., STURANI M. & ZUCALI M. (accepted with revision). Urban geoheritage as a resource for Earth Science education: examples from Milan metropolitan area. Rendiconti Online Della Società Geologica Italiana\* .*

\* These articles will present some differences in the published versions.

## 5.1

# **Pre-Service Teachers attitudes in planning and scheduling geofield trip at secondary level: a case study.**

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### ABSTRACT

Fieldwork and fieldtrips have been recognized to have a crucial role in learning Geosciences. Nevertheless, planning and technical difficulties accompany the realization of field activities; among these the teachers' attitude to approach Geosciences in the field. Here we present the results of a research carried out in the frame of the TFA 2<sup>nd</sup> cycle (University of Milan). The main goals were to teach participants how and when plan field trips in Geosciences secondary level year schedule and to investigate their teaching approach in the field. The results show that a traditional teachers-centered approach to field didactics dominate the data set and that their ability in field trip planning seems to depend on their previous experience as students. The sites selection confirm the great potential the Italian territory express in terms of field trip variety and feasibility.

### RIASSUNTO

Le attività didattiche in campo e gli itinerari didattici sul terreno hanno un ruolo cruciale nell'apprendimento delle Geoscienze. Ciò nonostante, difficoltà organizzative e tecniche spesso limitano la realizzazione di attività sul terreno; tra queste anche l'attitudine degli insegnanti a svolgere attività al di fuori dell'aula. Vengono qui presentati i risultati di una ricerca condotta nell'ambito del percorso di formazione degli insegnanti (TFA secondo ciclo, Università degli Studi di Milano). Gli obiettivi erano principalmente quelli di affrontare le tematiche relative alla progettazione delle uscite sul terreno e di verificare il tipo di approccio proposto. I risultati evidenziano la prevalenza di un approccio tradizionale, centrato sulla figura del docente e influenzato dalle esperienze pregresse.

### KEY WORDS

Geosciences, fieldtrip, education, teaching approach, teachers' training, landscape

## PAROLE CHIAVE

Geoscienze, escursioni sul terreno, strategie didattiche, formazione degli insegnanti, territorio.

## INTRODUCTION

### *1.1 Field trip and Geosciences education*

*“Students could view slides of a dune and investigate quartz grains in the laboratory, but it is only by climbing the steep front slope of a sand dune, that a student could receive a direct sensory-motor experience of learning about the structure of a dune”.* (Orion, 2003).

Fieldtrip is widely considered a powerful method to learn all the Natural Science and Geography but it is in the domain of Earth-Science learning where they play a central, if not unavoidable, role. This is because fieldwork allows students to experience directly with *“concrete phenomena and materials”* (Orion, 1993).

Since fieldtrip (FT) represents a way to insert classroom in the real world, benefits from field activities are various, moving from a deepest comprehension of knowledge to the acquisition of specific skills and abilities. These goals are pointed out by many authors (e.g the review on Geosciences education by King, 2008):

- FT promotes a better understanding of Geosciences fundamental concepts (Kern & Carpenter, 1986; Compiani & Carneiro, 1996; Vasconcelos & Salvador, 2003; Elkins, & Elkins, 2007; Tretinjak & Riggs, 2008).
- FT is a perfect occasion to contextualize all the ‘what’, ‘how’ and ‘when’ questions emerged in classroom (from Orion, 1989).
- The interplay between observation and testing of ideas is a crucial point in scientific thinking; FT plays a key role in developing this habit of mind. In particular FT enhances specific spatial-temporal skills since it *“helps students develop a feel for Earth processes and a sense of scale, and strengthens their ability to integrate fragmentary information, to reason spatially and temporally, and to critique the quality of observational data”* (Kastens. et al. 2009).

- FT allows a systemic approach to matters and promote an integrated vision of different disciplines (Assaraf & Orion, 2005; Orion, 2007; Orion 2014; Ireton et al., 1997).
- Since FTs provide students with a real world experience, they are a natural opportunity to employ the best practice of discovering-based and inquiry-based learning techniques, enhancing critical thinking and problem solving skills (King, 2008).

Out of the Geosciences contest, we can find many papers on field trip in the general sense of outdoor activities for students, in wild and natural environment, focusing on different type of benefits which relates to learner in both the individual and collective level. The first concerns the psychomotor, cognitive and affective development of the individuals, the second the social integration process and the development of knowledgeable active citizens (among others Morris, 2003; Dillon et al., 2006; Muñoz, 2009). In general, such literature evidences how direct experience of the natural environment can have significant mental and physical health benefits and can enhance self-esteem and self-confidence. Researches regarding more specifically Geosciences education in the field have been also published (see for example Garavaglia & Pelfini, 2011; Bollati et al., 2013, 2014, 2016; Pelfini et al., 2016; Henriques et al., 2012).

### *1.2 Field trip and earth-science teacher training*

*“Since field education and geoscience education are so inextricably linked, we should make the most of each in promoting the other”* (King, 2008)

Despite what envisaged by King, recent papers denounce a general decline of field activities in primary and secondary Earth-Science courses (Tretinyac & Riggs 2008). Increasing costs, logistics, strong safety protocol, legal implication in case of accident are some of the factors that demotivate teachers to plan field activities. Some authors pointed out that, another limiting factor depend by “the unfamiliarity with conducting field trips and the lack of curriculum materials relevant to field trip” (Elkins & Elkins 2007). In addition, Geosciences student textbooks rarely include sections dedicated to field activities (Sturani, 2016). Lewis (2008) in a paper on historical studies about Geosciences Teacher training in the 20th century in the USA, shows that for a long time training programs “focused more on enriching teachers Geosciences content knowledge” than on didactic Geosciences specific methodologies and he let deduce how fieldwork training represent a crucial step in pre-service

primary/secondary teaching Geosciences programs. Fieldwork has represented also the most common educational approach outside the classroom in teachers' training in England (Kendal, 2008). However, if there is a good number of studies citing the benefits of these kind of programs in promoting teachers Geosciences content knowledge (Michael & O'Neal, 2002; Mattox & Baab, 2004; Thomson et al., 2006; Hemler & Repine, 2006; Tretinyac & Riggs 2008), only few ones focus on the attitude of pre-service teacher towards fields activities (Moseley et al.2002; Chang & Hong, 2007; Costillo et a., 2011). In the Italian context, some authors have tried to fill this gap with manuals targeted at novice teachers including chapters dedicated to field activities in the Geosciences domain (Ferrero et al, 2004a, 2004b; Stoppa 2014).

Some works try to measure the effectiveness of the training program on novice teacher's "attitude toward science, confidence in teaching science, and inquiry understanding and skills" (Huntoon et al., 2001; Nugent et al 2008, 2012). Nevertheless, there are no information about the impact of such programs on trainees' skills and abilities in scheduling FT.

The main aim of this research is to investigate, in a sample of Italian pre-service teachers frequenting the TFA (Active Formative Apprenticeship - Tirocinio Formativo attivo - for acquiring the license for teaching Science in the secondary school), both the role of their prerequisites and previous attitude towards planning fieldtrips activities and the effectiveness of the course program in enhancing this specific didactic ability. The course where the research has been carried out is a module of the main course on Education in Geosciences, dedicated to the teaching of laboratorial activities indoor and outdoor.

More in detail we want to analyze if: 1) there is any correlation between pre-service teachers' academic background and their exam score in the examined sample; 2) there is any correlation between pre-service teacher's experience as student and their attitude in planning FT 3) we can indirectly have information about the educational potential the Italian territory can provide.

## METHODS



During the course educational strategies about Geosciences teaching and the key role that field work provides to overcome the main cognitive obstacles imposed by the discipline were discussed with a class composed by seventies pre-service Science teachers. Participants faced with exercises and examples of teaching leading techniques during FT. The Italian National Curriculum indications for all High schools were also analyzed, in order to identify where and when schedule field activities and FT. This considering that FT to be didactically effective need to be a part of the annual program and not a sporadic and isolated event (Orion, 1993). An urban geological trip, in the center of Milan, was also organized in order to put into practice some of the inquiry approaches.

The future teachers were asked to produce a FT lesson plan for high school class, for their exam, by using a defined format (Fig.1). Location, duration, school typology and all educational strategies were freely definable.

The way used by trainees to organize their final projects were also considered to check their attitude towards FT. The seventies formats constitute the analyzed dataset. For the evaluation, three primary indicators were considered: general feasibility (logistics, safety, costs, time scheduling, location, potentiality); educational coherence (between FT educational goals and annual scheduling); didactic feasibility (coherence between educational goals of trips and planned didactic strategies).

In order to statistically test the presence and the strength of a correlation between the obtained test grade and previous experiences, we formulated two different regression models.

<p align="center"><b>Field trip lesson plan format</b></p> <p align="center">Laboratorio Didattico di Scienze della Terra - TFA 2°Ciclo A054/A060 / Università di Milano</p>						
<u>Applicant:</u> Surname ..... Name .....						
<u>Field Trip Title:</u>				<u>Overall Aims:</u>		
<u>Locality:</u> .....		<u>Province</u> ( )		<u>Reference maps:</u>		<i>(scale 1:15000/ 1:25000)</i>
<u>N° involved classes</u>		<u>Curriculum Year</u>	<u>Type of high school</u>		<u>Trip time in annual scheduling</u>	
<u>N° accompanying teachers /guides</u>		<i>(1°/2°/3°/4°/5°)</i>	<i>(Liceo/I.Tecnico/ I.Professionale)</i>			
<u>Transportation arrangements:</u>	<u>Costs/person (€)</u>	<u>Itinerary lenght</u>	<u>altitude difference</u>	<u>duration of the trip</u>	<u>N° scheduled break</u>	<u>(lunch/rest)</u>
		<i>(Km)</i>	<i>(m)</i>	<i>(h) :</i>		
<u>Geoscience knowledges in which the student is expected to achieve a better and deepest comprehension</u>				<u>Skills and field abilities the student is expected to achieve</u>		
<u>Annual scheduled contents involved</u>				<u>cross curricular opportunities</u>		
<u>Preparatory class activities to field trip :</u>						
<u>Working sheets needed :</u>				<u>Supplies and equipment needed (data collection, safety) :</u> 1) collective: 2) individual:		
<u>Description of field activities</u>				<u>Time allocated</u>	<u>Description of the employed didactic strategies</u> <i>(teacher/student centered; descriptive/Inquired based; instructional / motivational)</i>	
<u>student's activities assesment</u>				<u>teaching activities assesment</u>		

Fig.1: The Field Trip lesson plan format

Previous experiences consider both academic courses and not academic field activities possibly influencing the planning and the organization of FT. The not academic experiences were pointed out during conversations, and common discussions.

In the first model we decided to use as the explicative variable relative to the exam evaluations (score) a dummy (a binary variable) to which assign the value 1 (one) for trainees with a clear previous academic experience in FT (participation and/or organization) and the value 0 (zero) for trainees without any FT experience (dummy ABE = Academic Background Experience). Moreover, a constant has been associated to this variable (CONST). In order to consider different FT experiences we built a second regression model in which we assigned value 1 (one) to the dummy also for trainees communicating to have had good experiences in FT participation and organization, even if not academic (related to sport activities, landscape frequentation thank to parents' nature passion, association activities etc.). (New dummy, APBE = Academic or Practical Background Experience).

## RESULTS

### *Evaluation of trainees*

Most of the TFA candidates result to be graduated in Natural Science *sensu latu* (Biology, Chemistry, Biochemistry etc.) degree courses mainly without specific activities and/or courses concerning the Geosciences domain, so they have no previous geographical or geological field experience. The remaining trainees took their master degree in natural, environmental, forestry, geological science etc, academic courses that include field activities. In view of that, we first analyzed final exam data in order to find an eventual correlation between score and previous backgrounds (Values are expressed in thirtieths).

Trainees were grouped in four categories in relation to their academic degrees. The results shows an average score of 25/30 for Chemistry graduates, who represent the 10% of the trainees' sample. The same score, 25,05/30, was reached by Biotechnology graduated (25,71%). A little better score 25,33/30 gains Biology graduated (38,57%) while 26,27/30 is the better average score reached by the category which aggregate Environmental Science and Geology graduated (25,71%). This category also shows the maximum number (5) of top scores (30/30. 30/30 *cum laude*).

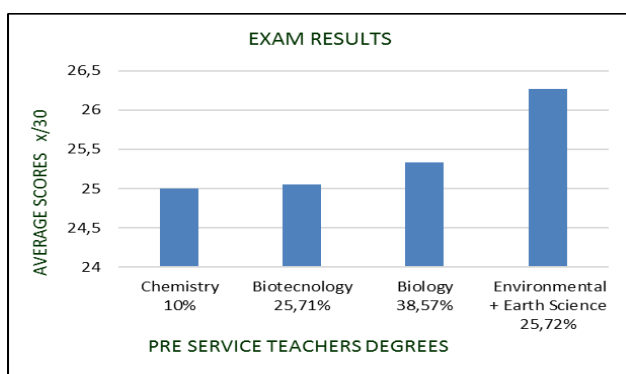


Fig. 2 Average text score

For what concern the first regression model, results are reported in tab.1.

Tab. 1 Results from the first model

Dependent value: SCORE	coefficient	t-test value	p-value	Adjusted R-squared =	N° of obs=
Predictor: ABE	3.24	2.70	0.009	0.08	70
Constant: CONST	25.07	61.89	0.000		

They show the presence of a positive and statistically significant correlation between the score and the previous academic FT experience. The low square R value, adjusted for degrees of freedom, is due to the shortage of observations with ABE value = 1

In this way we can affirm that candidates with clear previous academic experiences, for what concern planning and realization of FT, have a high probability to obtain a final score better than the average (25/30) of the remaining candidates, which varies in the order of +/- 3.24/30.

For what concern the second regression model, results are shown in tab.2

Tab. 2 Results from the second model.

Dependent value: SCORE	coefficient	t-test value	p-value	Adjusted R-squared =	N° of obs=
Predictor: ABE	5,14	10,18	0.000	0.59	70
Constant: CONST	22,94	65.15	0.000		

Results appear to be encouraging. They strengthen the previous hypothesis; moreover, the results evidence a considerable increasing of the evaluation general level of statistical significance.

Evaluations carried out with the second model evidence how candidates (the future teachers in the examined sample) with previous experiences in Geosciences FT, both academic and not academic, have a higher probability to obtain a final score greater the average one (22.94/30) variable in a range of +/- 5,14/30.

### *The choice of field educational strategies.*

Referring to the educational strategies planned by trainees, the results show that only in few cases they would gain the outdoor activities in a discovery/motivational way (2/70). Generally, a guided inquiry with focus generated from trainees' field experience covers a 30% of plans, while in most of the cases, over 60%, plans were dominated by an instructional/ descriptive teachers' leading style.

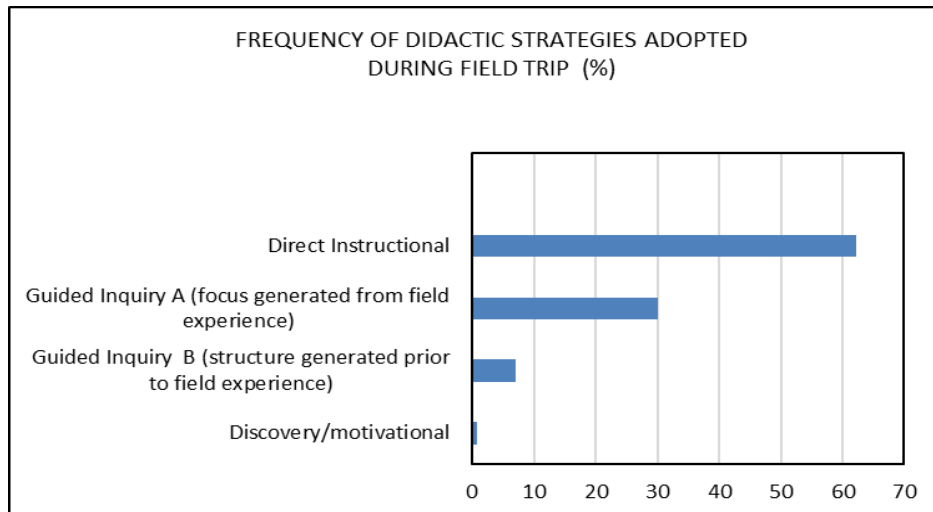


Fig. 3 Educational strategies proposed by trainees for FT

### *The educational potential of Italian territory*

The sites selection shows a dominance of Lombardy's and Piedmont's locations. This is obvious as the TFA was ran in the University of Milan and most of the participants lives in northwestern Italy. This would explain why mountainous environments are prevalent in the FT projects (fig.4). Anyway, ten Italian regions, along the entire peninsula, were involved with FT,

covering seven different geographical and geomorphological environments (Fig. 4). These main environments were defined by their predominant physiographic elements.

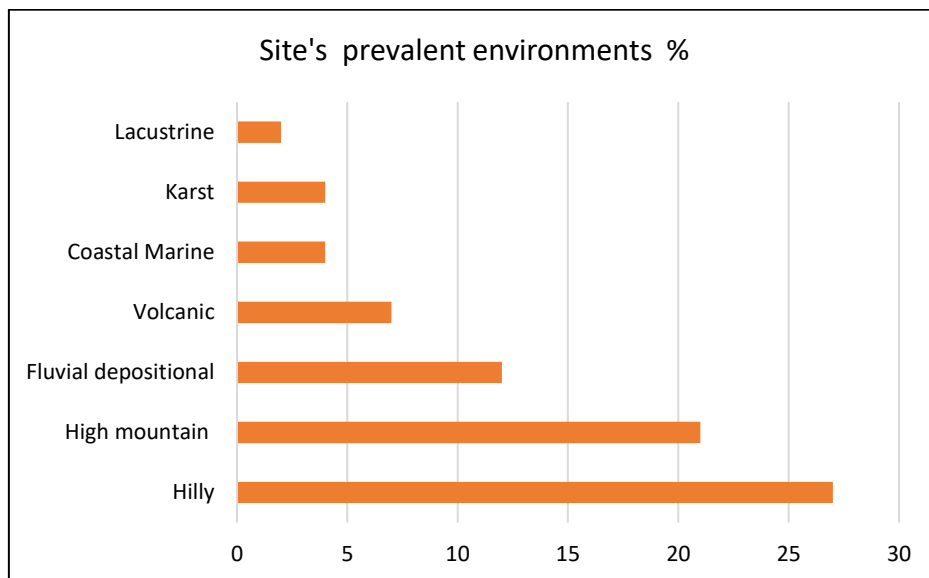


Fig. 4 Different geographical and geomorphological environment linked with trainees' projects.

Due to the peculiar character of each site, various topics were covered during the proposed FTs. The main featured topics in plans are showed in Fig 5. Twelve different Earth-Science topics have been proposed as considered relevant for the curricula. Ecology, History, Art and Architecture have been also explored, with significance as cross-curricula opportunities (Fig. 5).

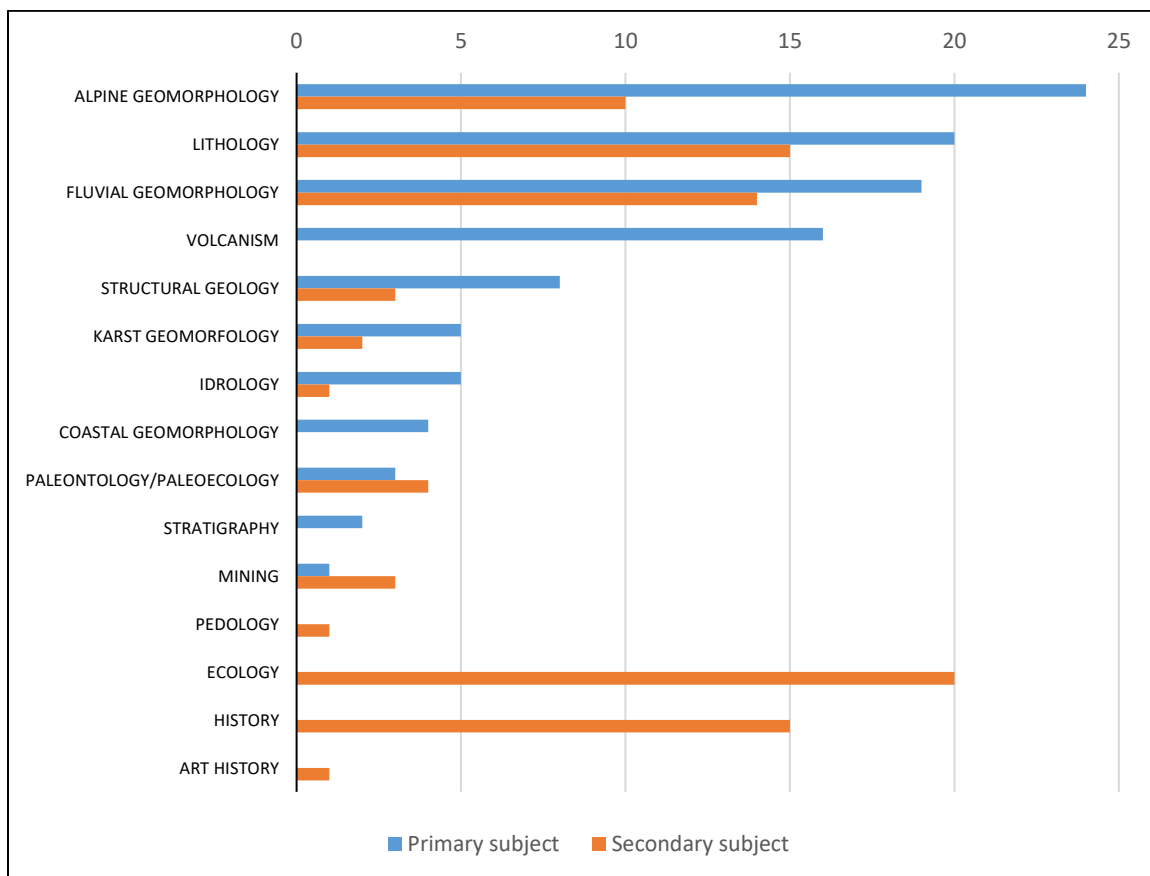


Fig. 5 The subjects matter included by trainees in their FT projects.

## DISCUSSION

### *Evaluation of trainees*

The very low variability between the test results at first glance seem to denote an absence of correlation between, apprentices degrees and scores, in the examined sample. Specific skills and abilities achieved during tertiary education, apparently seem not to influence the prospective of organize FT and fieldwork in high school. Nevertheless, the two statistical models, which consider respectively the fieldwork linked with the academic formation and also this latter joined with the personal field experiences, even if experimented outside the formation period, let suppose that greater is the previous field experience, the greater is the possibility to get score higher than the average for each group. Obviously, being the sample small and the assessment of previous experience deduced after discussions, the result can be only referred to the examined trainee's sample. Anyway, the results are encouraging and suggest continuing the research.

The brainstorming allowed also deducing how the teaching was not the first job choice for someone; Somebody probably hoped, or hope, to spend his competence in different working domains. Graduated in Environmental Sciences (in a broad sense) who shows a higher frequency of top scores (30/30 and 30/30 cum laude) seems to be more ductile to achieve the didactic skills requested by the teacher's profile.

#### *The choice of field educational strategies.*

If we compare trainees results, especially if we consider their proposals in terms of educational feasibility (fig.3), it appears clear that the experiential learning approach is not instinctive. In the majority of case (60%) the planned outdoor activities are leaded by teachers in an instructional/descriptive style; only in one third of plans trainees present an inquiry approach and only in very few cases the FT are proposed in a discovery/motivational way. This reflects the Italian educational practice at secondary level, which is traditionally teacher-centered and poorly participative: "Active didactics, group work, cooperative learning are forms that are beginning to be more frequent in nursery and primary school, while they are still rare experiences in the secondary school." (MIUR 2003)

Even if during the training course the student-centered approach was underlined, the future teachers seem to replicate their previous experience as students.

Nugent et al.(2008) remark that the majority of undergraduate science course in the American colleges are rich in contents but poor in engaging students in active investigation, with a clear impact on future science educators: "*It is difficult for our future teachers to create effective and engaging science courses for their students without exposure to such experiences*". Moreover, as observed by Tretinac & Riggs (2008), if we don't let pre service teachers to gain field experiences they remain unaware of the educational potential the outdoor environment can provide.

#### *Italy's landscape variety*

The location of the proposed FTs shows how rich and versatile the Italian territory is for outdoor educational approaches (fig.4). As shown by results, topics relevant for High school science curricula are in almost all cases touched either as primary subject either as secondary ones (Fig.5). Anyway, the learning goals of such a versatile territory are not limited to the Geosciences ones since they could be extended to those of Geography, Economy and Citizenship education etc., as mentioned in the plan of apprentices.



## CONCLUSIONS

The present research even if limited to a small sample allow deducing some conclusions:

Even if fieldwork and FT are considered very important in Geosciences education, the interviewed future Italian teachers seem to have poorly experienced them and FTs appear difficult to be planned considering, other than traditional strategies, active and inquiry approaches.

Results confirm literature for what concern the importance to insert FT as a part of the annual program and not a sporadic event, in order to be didactically effective. Moreover, also cities and towns represent an opportunity for FT as experimented by the sample TFA apprentices (e.g. urban geology and urban geomorphology; Thornbush, 2015).

The future teachers' background, their motivation in choosing teaching as their job, the rich literature on problems concerning teaching Science and our results suggest that a more designed path for science teachers at academic level could be advantageous. This is even more necessary for what concern Geosciences as evidenced during the most recent cultural events and congresses including a thematic session dedicated to Geoscience education.

## ACKNOWLEDGMENTS

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## **Urban geoheritage as a resource for Earth Science education: examples from Milan metropolitan area**

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### **ABSTRACT**

Fieldwork and field activities represent key experiences in fixing knowledge, acquiring competences and skills in Earth Science education. They can be also addressed to the discovery of geodiversity and geoheritage, an interesting starting point to approach Earth Science both in natural and urbanized areas. Interdisciplinary approaches including human and geological history, literature, art, chemistry, physics and physical education etc. are favored. Urban areas, differently inserted in the landscape, offer great opportunities for Earth Science education; moreover, urban geoheritage is becoming a new tool in cultural heritage. In the present work, two different experiences are proposed, in order to highlight the importance of open-air laboratory for different targets: from students to future teachers. An itinerary in the city center of Milan (Italy), for collecting and classifying lithological data from buildings and street floors, becomes the instrument to shift the focus from urban artifacts to the provenance sites located all around Northern Italy to open to the geology and geomorphology of the Italian Alps. A “hydrological” itinerary, moving inside the “Cerchia dei Navigli”, a canal belt around the city center, and in the southern surroundings of Milan, allows approaching present and past characteristics of fluvial geomorphology and its link with ground-waters.

**KEY WORDS:** Field activities, Earth Science education, urban geomorphology, ground water, geodiversity, geoheritage.

## RIASSUNTO

Le attività didattiche sul terreno costituiscono esperienze fondamentali per fissare le conoscenze e acquisire competenze e abilità nel campo delle Scienze della Terra. Tali attività “all’aperto” possono essere anche indirizzate alla scoperta della geodiversità e del patrimonio geologico, un ulteriore punto di partenza per la didattica delle Scienze della Terra, considerando sia aree naturali che zone urbanizzate. Sono inoltre favoriti anche gli approcci interdisciplinari che includono la storia geologica e antropica, letteratura, arte, chimica, fisica educazione fisica ecc. Le aree urbane, inserite in modo vario nel paesaggio geografico fisico, offrono grandi opportunità per la didattica delle Scienze della Terra; il patrimonio geologico urbano sta diventando inoltre un nuovo ambito didattico all’interno del patrimonio culturale. In questo lavoro vengono presentate due esperienze didattiche che evidenziano l’importanza dei “laboratori all’aperto” per diverse tipologie di utenti, dagli studenti ai futuri insegnanti. Un itinerario nel centro di Milano, per raccogliere e classificare dati litologici osservando edifici e pavimentazioni stradali ha rappresentato uno strumento per collegare i manufatti urbani con i siti di provenienza dei materiali da costruzione e introdurre alla geologia e alla geomorfologia delle Alpi. Un itinerario idrologico che si sviluppa nella “cerchia dei navigli” e alla periferia sud di Milano, permette di introdurre le caratteristiche attuali e passate della geomorfologia fluviale e il suo legame con le acque sotterranee.

**PAROLE CHIAVE:** attività di campo, didattica delle Scienze della Terra, geomorfologia urbana, acque sotterranee, geodiversità, patrimonio geologico.

## INTRODUCTION

Fieldwork and field activities are considered key experiences in fixing knowledge, acquiring competences and skills. Fieldtrips represent great opportunities for students to observe and analyze the landscape they live in (Magagna, 2016). Moreover they favor enquiring-based approaches in Earth Science education (King, 2006; Dillon et al., 2006; Hawley, 2012; Pelfini et al., 2016; Giudici et al., 2016). Field experiences can be also addressed to the discovery of geodiversity and geoheritage. (sensu Gray,2013). Nevertheless, many are the possible problems for outdoor lessons and activities. They are related to traveling distances, economic implications, access limitations, insurances and, in particular, the annual hours for science lessons (Tretinyac & Riggs, 2008). In this framework big towns, small cities and also villages, offer great



opportunities for Earth Science education through an interdisciplinary approach which includes, among the others: history, literature, art and also chemistry, physics and physical education (Pelfini et al., 2016).

Urban areas are characterized by a great geodiversity, providing different services to society (table 1) (Gray et al., 2013). Urban geodiversity is well perceptible in terms of different kinds of rocks used for buildings and in term of landforms that represent conditioning factors for human settlements and the base on, and around which, cities have developed through centuries. Nevertheless geomorphological features should include anthropogenic landforms generated by the re-modeling of Earth surface natural features by mankind (Pica et al., 2016).

In particular, watercourses everywhere represented a conditioning feature for human settlements even if mankind significantly modified them, for adapting to following urban needs. Consequently urbanized areas are becoming a new tool to understand also the role of human activity, considered nowadays as the third geomorphologic agent in shaping the landscape (anthropogenic geomorphology) (Ly et al., 2017). Urban geomorphology, an interdisciplinary area of research focusing on the effects of urbanization on natural landforms and anthropogenic structures, is also considered fundamental in investigating human impacts on different geomorphological environments (Thornbush, 2015).

Urban geoheritage is becoming as well a new tool in cultural heritage. Recent researches outline for example the magnificence of Italian towns, like the iconic Rome (Pica et al., 2016). Moreover, urban geoheritage represents a great opportunity in teaching activities for different targets: children, students, general public (e.g. Del Lama et al., 2015) and also teachers (table 1, cultural services).

Tab. 1 Contextualization of the analyzed urban topics in the framework of the abiotic ecosystem services proposed by Gray et al. (2013)

<i>Abiotic ecosystem services (according to Gray, 2013)</i>	<i>Rocks for buildings and floors in urban areas</i>	<i>Hydrological cycle in urban areas</i>
Regulating		Atmospheric processes (e.g. hydrological cycle).
Provisioning	Construction materials (e.g. stone, brick, aggregates)	Food and drink (e.g. freshwater & mineral water)
Supporting		Burial and storage (groundwater)
Cultural	Geotourism & leisure Education & employment (e.g. sites for field trips)	

The aims of this paper are to: 1) propose two examples of educational activities carried out in Milan and its south surrounding, 2) outline the importance of outdoor urban activities for: i) observing the landscape evolution caused by human modeling; ii) linking the buildings material with the provenance areas and quarry districts around the Alps to introduce discussion about Alpine geological domains; iii) connecting the evidence of fluvial morphology with urban ground waters and sedimentological data.

## METHODS

### *From building and floors lithology to the geology of the Alps*

A first educational activity was realized through an itinerary proposed to future teachers during their course on Earth Science education strategies carried out at Università degli Studi di Milano in the frame of the formation experience for secondary school teachers. The course was included in the formation program of TFA (Training course for acquiring the qualification for teaching at the high school level). The activity was prepared collecting all the information about the buildings material used in Milan (e.g., Bugini & Folli, 2008). The itinerary develops in the city centre and includes eight possible stops. The stops are not mandatory and the itinerary can be modulated according to the educational necessities. Trainees were asked to collect lithological data observing buildings and street floors, in order to move the attention from urban artefacts to the provenance area and the quarry district located all around the Northern Italy (the most represented are Valtellina and Ossola Valley), and sometimes abroad. The use of an easily manageable procedure for rocks classification was proposed to teachers (Fig. 1). Moreover, they were asked to correlate rock features with their specific use like paving, buildings structures and ornaments.

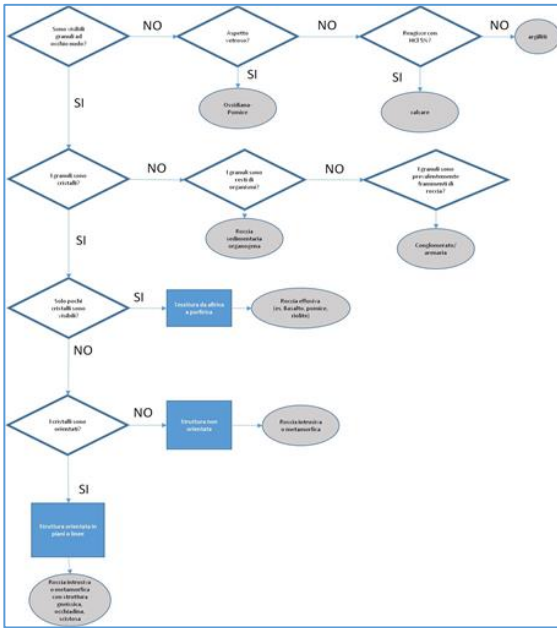


Fig. 1 – Schematic flow-chart used on the field to classify rocks of urban buildings.

Fig.1 – Schema utilizzato in campo per classificare le rocce degli edifici urbani.

This kind of experiences let the apprentices (teachers, students, citizens) to approach Earth Science themes in an unconventional way. The pleasure that comes out by the revelation of the beauty of rocks used in the architectures, or from the unexpected discovery of fossils lying in a bar counter, is a powerful key to make Geoscience more accessible and catching. The itinerary was planned to be concluded in about 4 hours.

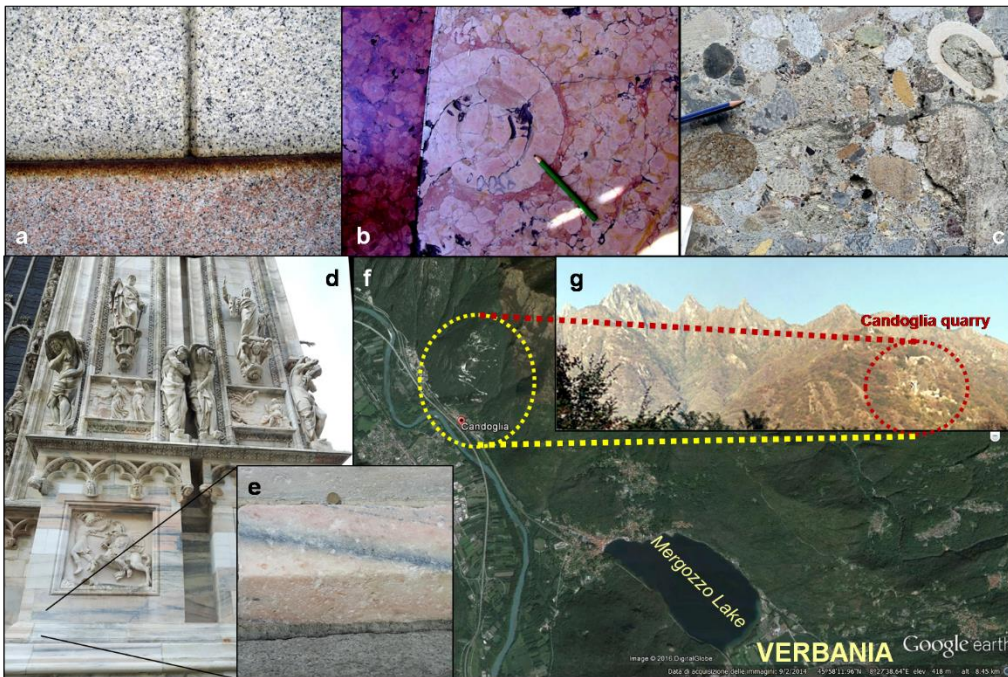


Fig. 2 – a) Corso Vittorio Emanuele pillars – White Granite (Montorfano) and Pink Granite (Baveno) – (Piemonte); b) Corso Vittorio Emanuele floors – Ammonitic limestone (Pietra di Verona); c) Piazza della Scala – “Ceppo Lombardo”; d) Duomo di Milano – Candoglia Marble and the correspondent quarry (f, g; Candoglia, VB, Piemonte).

Fig. 2 - a) Pilastrini lungo Corso Vittorio Emanuele – Granito bianco (Montorfano) e Granito rosa (Baveno) – (Piemonte); b) pavimentazione lungo Corso Vittorio Emanuele – Calcarei ammonitici (Pietra di Verona); c) Piazza della Scala – “Ceppo Lombardo”; d) Duomo di Milano – Marmo di Candoglia e la cava originaria del materiale (f, g; Candoglia, VB, Piemonte).

*Hydrological and geomorphological itineraries in urban areas.*

During the itineraries organization, the analysis of historical information and geomorphological, hydrological and sedimentological data allowed to identify remnants of different hydrographic features testifying a more evident fluvial geomorphology as well as a more dense watercourses network. Subsurface data allowed to detect the contribution of superficial and ground-waters and of infrastructures for water management in shaping the current urban landscape. Historical material have been analysed for individuating changes in the natural and artificial water circulation around the city centre (“Cerchia dei Navigli”). Topographic evidences of ancient and current fluvial processes modelling the surroundings of Milan have been investigated too (Carta Tecnica regionale - “Morfologia” Foglio B6 Milano, Regione Lombardia, 1983,; Carta geologica 1:50000, Foglio Carg 118 - Milano, ISPRA, 2016).

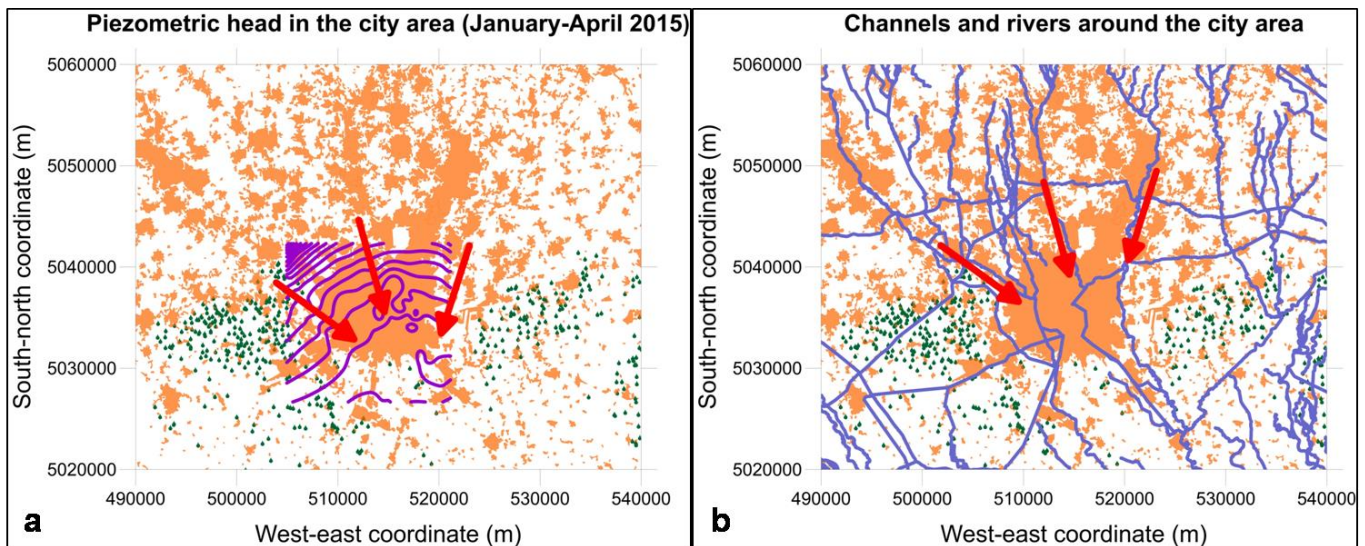


Fig. 3 – Hydro(geo)logical features in the Milan metropolitan area, obtained by processing data from Webgis of Regione Lombardia (<http://www.geoportale.regione.lombardia.it/>) (coordinates system: WGS84) and the environmental information system (SIA) of the Città metropolitana di Milano (<http://ambiente.provincia.milano.it/sia/>). Isopiezometric lines in violet in figure (a); Main channels and rivers (b). Interaction between surface and underground waterflows reported as green dots (“fontanili”) (a, b).

Fig. 3 – Caratteristiche idro(geo)logiche dell'area metropolitana di Milano ottenute dall'elaborazione dei dati derivati dal Webgis della Regione Lombardia (<http://www.geoportale.regione.lombardia.it/>) (coordinates system: WGS84) e dal Sistema Informativo Ambientale (SIA) della Città metropolitana di Milano (<http://ambiente.provincia.milano.it/sia/>). Isopieze in viola (a); Principali canali e corsi d'acqua (b). Interazione tra flussi superficiali e sotterranei riportati come punti verdi (“fontanili”) (a, b).

## RESULTS

### *From building and floors lithology to the geology of the Alps.*

The itinerary has been already tested. Field activities in the center on Milan had a very positive acceptance by the trainees and an almost immediate positive feedback since 10% of teachers started in replicating the experience with their own students, also in different towns just few weeks after the TFA fieldtrip.

### *Hydrological and geomorphological itineraries in urban areas*

Two possible “hydrological” itineraries were detected for geotouristic purposes. The first one is located inside the “Cerchia dei Navigli” (the ring of streets where navigable canals were present until early XXth Century); the second one crosses a sample area in the southern surroundings of Milan and joins cultural values and evidences of the past fluvial morphology.

At a large scale vision, the convergence of surface and groundwater flows towards the city centre (red arrows in fig. 3) is evident. This is an effect of the control exerted by water infrastructures on rivers and channels reaching the city from the North and of the concentration of pumping stations in the city area, which caused a depression cone in the aquifer and a converging groundwater flow towards the city centre.

The area selected in southern of Milan is located around the Chiaravalle abbey, and it is characterised by the presence of geomorphological features (fluvial terraces, palaeo meanders, etc.), a sand-and-gravel open-air quarry, an artificial channel (Vettabbia). The integration of subsurface data permits also to draw cross-sections of the shallow subsurface (down to about 50 m) and to illustrate the relationship between surface (geo- and hydro-logical) processes with the buried geological (lato sensu) structures.

At present, the urban geomorphological itineraries have been planned but not tested with students yet.

## DISCUSSION AND CONCLUSIONS

As only partially tested, discussion and conclusions on educational application will be referred only to the first activity. In particular it is possible to highlight: i) the role of rock mechanical and mineralogic-petrographic proprieties in the choice of stones for building and street floors, thanks to their durability and easiness to be shaped; ii) the contribute of minerals, fossils to the stone aesthetic value in the choice of materials used for city buildings and floors;

iii) the role of geoactivities for detecting the links between the present features of the old center of the town with the geology of the Italian Alps. The proposed outdoor activities obtained a great appreciation by trainees.

The interest in the replication of the first urban geological itinerary demonstrates how outdoor activities are easily practicable as they can be realized closely to the school, obviating economical and transport difficulties. Moreover, they confirm to represent a valid opportunity for increasing knowledge in Earth Science.

The second activity regarding “water itineraries” will allow to recognize the different hydrographic features in Milan, helping the knowledge of the present-day urban landscape, the geomorphological elements modeled by both natural and artificial processes: (fluvial geomorphology and anthropic geomorphology). Moreover a hydrological itinerary should allow to highlight i) the natural role of water in modeling landscape; ii) the role of water infrastructures (channels, sewage and aqueduct networks, etc.) in changing the landscape and, consequently, the role of human activities as geomorphic agent; iii) the interaction between surface and ground water in correspondence of rivers and channels and of flowing wells.

Both the outdoor activities can be considered good examples not only to familiarize with urban geomorphology, but also to introduce students to new topics as geoheritage and anthropogenic geomorphology and to applied problems such as management of water resources and flood hazard and risk analysis.

## ACKNOWLEDGMENTS

The authors thank the trainees participating to the outdoor educational activities and Regione Lombardia (Direzione Generale Dipartimento Territorio, Urbanistica e Difesa del Suolo) for providing data on the area Città Metropolitana di Milano.

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6.

## CHANGING THE PARADIGM IN GEOSCIENCES TEACHING FOR SECONDARY SCHOOL

- I. *Sturani M., Pelfini M. et al, (in preparation for submission). Introducing Inquiry approach to Geosciences teaching in early High School: a pilot science education project in north western Italy, FOR SUBMISSION TO Journal of Research and Didactics in Geography (J-READING).*

## 6.1

# **Introducing Inquiry approach to Geosciences teaching in early High School: a pilot science education project in north western Italy.**

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### *ABSTRACT*

*In 2010 important innovations were introduced in Italy in science teaching at secondary level due to a new educational reform. Recent surveys reveal that Italian teachers are finding it hard to accomplish the Geosciences programmatic indication for the 1<sup>st</sup> year under the new framework. For this reason an educational module on the reading of landscape with an inquire based approach was devised and tested with a sample of Italian High school teachers and their students. A qualitative-quantitative explorative case study was ran by collecting data with pre and post intervention questionnaire aiming to shed light on some aspects of module's effectiveness. While considering the small scale of the sample size, results revealed that the introduction of an inquiry approach enhance students' interest and attitude towards the study of Geosciences issues while promoting team-working and a wide variety of skills. Furthermore, the enactment of the module had an impact on teachers' motivation to tackle the Physical Geography issues in question under a new light and left a positive mark on their teaching habits months after its completion. On the other hand, the cross-curricular opportunity of the educational module with the Geography syllabus, that is one of the programmatic goal of the 1<sup>st</sup> year reform indications, still remains an unaccomplished task.*

### *ABSTRACT*

Nel 2010 per effetto della riforma del Sistema educativo italiano, sono state introdotte importanti novità nell'insegnamento delle scienze a livello dell'istruzione liceale. Tuttavia recenti ricerche hanno evidenziato come gli insegnanti faticino a completare le indicazioni di programma per la parte di Geoscienze previste dalla riforma al primo anno di Liceo. Allo scopo di trovare una soluzione a questo problema è stato ideato e testato insieme ad un campione di docenti e di loro studenti un modulo didattico sulla *lettura del paesaggio* basato sul metodo detto Investigativo. Per mezzo di questionari pre e post intervento sono stati raccolti dati quali-

quantitativi, sulla base di questi è stato quindi condotto uno studio esplorativo al fine di testare l'efficacia di alcuni aspetti del modulo didattico. Pur considerando le ridotte dimensioni del campione testato, i risultati mostrano che l'introduzione di un approccio *inquiry* accende l'interesse degli studenti e li incentiva a studiare i temi di Geoscienze in oggetto, promuovendo contemporaneamente l'abitudine al lavoro di squadra e la sperimentazione di svariate abilità operative. La messa in atto del progetto ha inoltre incentivato i docenti ad affrontare gli argomenti di Geografia Fisica in oggetto da una nuova prospettiva, lasciando un'impronta nella loro prassi didattica a distanza di mesi dall'intervento. Per un altro verso, il progetto non è stato in grado di soddisfare le esigenze di interdisciplinarietà col corso di Geografia come auspicato dalle indicazioni nazionali della riforma.

#### **KEY WORDS**

*Geosciences, inquiry based science education, teaching approach, the reading of landscape, outdoor learning.*

#### **PAROLE CHIAVE**

Geoscienze, inquiry based science education, strategie didattiche, lettura del paesaggio, outdoor learning.

### **INTRODUCTION**

#### *Geosciences teaching in the Italian High School reformed context*

In 2010, a secondary school reform enters into force in Italy, introducing important innovations in Geosciences teaching in the national high-school known as "*Lyceum*"—school specifically tailored to prepare university access. In fact, if before the reform the geosciences as a subject were only taught during the final year, these are now introduced from the very beginning and remain present in the science curricula throughout the five-year period, along with chemistry and biology. The national guidelines of the reform concern both methodological indications as well as novelties as to the key contents (Ministerial Decree No. 211 of 7/10/2010).

The science curriculum for the first year includes the teaching of introductory chemistry, Mathematical Geography - the motion of Earth and its consequences - and of Physical Geography - the study of the surface of Earth from a geomorphological point of view.

As for the methodological guidelines devised for teachers, the legislators have placed particular emphasis on the introduction of practical and field activities and, given the subjects

taught in physical geography, on making sure to coordinate the science syllabus together with the (human) Geography teacher (Ministerial Decree No. 211 of 7/10/2010).

Given the above situation, researches carried out on geosciences teaching in high schools after the reform have highlighted some critical issues: the risk of marginalization of the discipline due to a lack of time (Tosetto 2011, Marini et al. 2012), a non-completion of the programmatic indications with regards to the choice of lesson subjects (Realdon, 2016, Sturani, 2016) and, in the teaching practice, the failure to adopt the experimental approach (field and laboratory) (Realdon 2016).

In particular, a survey conducted on a sample of first year teaching programs (Sturani, 2016) showed that only a small minority of teachers adhered to the national guidelines with regards to Physical Geography, and that this minority gave space to subjects (astrophysics) that were not programmed for that year.

Furthermore, the analysis of new first year science textbooks (Sturani, 2016) highlighted a lack of space given to physical geography, especially in the most used ones. The analysis also showed that an encyclopedic structure of the textbook was generally privileged, being an approach that gives teachers a greater freedom of choice in the programming phase (Sturani, 2016).

It is not easy to understand why the Physical Geography part expected in the curricula ends up being so sacrificed in the activity of teachers. Among the reasons, there may be the fact that the amount of hours to complete the syllabus is limited if considered in relation to the volume of contents to deliver (Tosetto, 2011; Marini et al, 2012), as well as the difficulty teachers encounter in renewing their well-established teaching habits (Davis, 2003, Fink & Stoll 2005) – problem that seems to be related to a high average age. In fact, in Europe the highest average age with regards to high school teachers has been registered in Italy - where in average the teachers are well over 55 - (Eurydice, 2013).

However, the factor that seems to have the highest influence in the decision making process of teachers when it comes to the programming phase is their cultural background: in Italy more than 55% of science teachers has a biology degree, i.e. no academic training in Geosciences (King, 2008, Lancellotti ,2016, Realdon, 2016).

The consequence of this is very well summarized by Scapellato (2013): *“Moreover, often Italian Earth Science teachers have a biological educational background and are ill at ease with the subject, therefore, they tend to cover the syllabus simply by following the textbook guidelines which are often poorly structured and encyclopaedic thus killing potential interest”*.

The fact that a lack of a specific academic background in teachers is a factor that strongly limits the teaching of Geosciences is also endorsed by researches conducted overseas (<https://www.earthmagazine.org/article/comment-high-school-earth-and-space-science-should-be-taught-geoscientists>).

## **MATERIAL AND METHOD.**

*The need for a change in educational paradigms: the introduction of an inquiry approach.*

Against this background, and especially in order to find solutions to the difficulties encountered by teachers in responding to the national guidelines for the first year, we decided to devise and test together a protocol of teaching actions to make the Physical Geography subjects in the syllabus more inspiring and effective for students on the one hand, and more engaging for teachers on the other.

The experimental phase would be followed by a data collection one, carried out by means of pre- and post- project questionnaires, as a way to measure both the feasibility and the success of the project in the teaching practice.

In conceiving the methodology for the project, inspiration was taken from that of the Inquiry Based Science Education - IBSE - because, as it has been well expressed in the Rocar European Community report: *“Inquiry-based science education (IBSE) has proved its efficacy at both primary and secondary levels in increasing children’s and students’ interest and attainments levels while at the same time stimulating teacher motivation.”* (European Commission, 2007).

In addition to the Rocar report, there is a wide body of literature that highlights the advantages presented by the IBSE approach with regards to science education (Bransdorf et al., 2000; Colburn, 2008; Duschl et al., 2008; Minner et al., 2010).

The IBSE educational approach was born in America more than half a century ago and was based on the constructivist educational theories by philosophers such as Dewey and pedagogues like Piaget, who considered students to be directly responsible for their own learning process. The constructivist teaching approach aims at fostering decision making and awareness in students during the learning process. Over time, IBSE has undergone many transformations, also lending itself to not always unambiguous interpretations (Barrow L. H., 2006). To clarify the matter, in 2000 the U.S. National Research Council published “Inquiry and the National Science Education Standards”, in which the method was formalized through the following five distinctive characteristics: Learner Engages in Scientifically Oriented Questions

- Learner Gives Priority to Evidence in Responding to Questions

- Learner Formulates Explanations from Evidence
- Learner Connects Explanations to Scientific Knowledge
- Learner Communicates and Justifies Explanations

These principles are then implemented in response to the epistemic characteristics of the discipline to which they are applied, especially when the Geosciences come into play, as they involve a high number of variables and in which the inquiry “*questions are often based on incomplete information about complex, interactive, and (ultimately) uncontrollable events*” (Pyle 2008).

With regards to the application of the method in the Physical Geography field, reference was made to the standards established by the British geographical school, considered a reference point in this field (Day T., 2012). In particular, in the planning of the phases of the inquiry, reference was made to the work of Roberts (2003), while for the definition of the inquiry questions that could be applicable to landscape reading reference was made to Rawling (2007), and, finally, for the different ways to conduct the inquiry on the field reference was made to that of Job (1999).

Given these premises, it is also worth pointing out that in the last decade the IBSE methodology has been widely promoted throughout Europe by means of specific programs. Among the best known are: FIBONACCI (<http://www.fibonacci-project.eu/>), La maine a la pate (<http://www.fondation-lamap.org/>), INQUIRE (<http://www.inquirebotany.org/en/>) and SAILS (<http://www.sails-project.eu/project.html>).

In Italy, one of dissemination schemes for the IBSE practice is called SID - Scientiam Inquierendo Discere. The SID has been promoted nationally since 2011 by the Accademia Nazionale dei Lincei in collaboration with the Associazione Nazionale degli Insegnanti di Scienze Naturali and with the patronage of the Ministry of Education, through a network of regional centres. (<http://www.anisn.it/scientiam.php>). Since 2011, thanks to the SID and the INQUIRE programs (Dorigotti 2013), a lot of IBSE projects have been carried out in Italian school. Despite this, few is known for what concern their assessments with the exception of the research on Inquire programs (Dovigo & Rocco 2013, Rocco 2015) and the works on the effectiveness of an IBSE training course for Geosciences teaching in secondary school (Scapellato et al., 2013; Scapellato, 2014).

Our research project partly joined the program of the Piedmont region SID centre for the years 2014-2016, thus benefiting from the support of specific skills for its realization). (see Appendix.1)

### *The Landscape Project*

In particular, the objective of the experimental teaching project was to promote the teaching/learning of the landscape forms, as required by the national guidelines for the first year science programs in high school, and to do so through an investigative path that favoured:

- The motivation and engagement of teachers, both in planning and in conducting the educational modules.
- The active participation of students, as suggested by the sample of students who took part to the project.
- A questioning and cross curricular approach.
- The practice of experimental field activities, as advocated by the national guidelines.
- An interdisciplinarity with the Geography course, as recommended by the national guidelines.

The underlying idea was to make the students work together in small groups on specific geomorphology subjects, through a process of disclosure/interpretation of a set of landforms shapes selected by the teacher because representative of the nearby territory, close to the school and easily reachable (Orion, 1993).

Now, being the object of the work the landscape as a whole, that is “*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*”, as quoted from the European Landscape Convention (2000), this would not be limited to the simple interpretation of the landforms, rather it inevitably would have forced students to consider historical, economic and social signs too. These aspects lend themselves to an interdisciplinary and parallel work between the Science and Geography courses in the first year of high school.

Within the IBSE methodology, the inquiry modes oscillate between an entirely teacher-directed approach to an entirely student-directed one; some authors propose a greater articulation of the approach (Rezba et al 1999, Bell et al, 2005) that has been eventually systematized by Benches & Bell (2008) in four main categories in which the method changes according to the goals to achieve:

- *Confirmative inquiry*: students are given a series of questions along with the procedures to find the answers. The results are already known. The purpose consists in confirming those results.
- *Structured inquiry*: students are given a series of questions, along with the procedures to find the answers. The results are already known. The students are asked to provide an explanation of the phenomenon based on their own understanding.

- *Guided inquiry*: the research questions are posed by the teacher, but the students have to identify and implement the methodological approach to find the answers.
- *Open inquiry*: the teacher only presents the research theme, while the students have to identify both the questions and the procedures that will be implemented independently in order to find the answers.

However, according to an interesting review on the modes of conduction of the IBSE method, Levi et al (2011) argue that the IBSE approach lends itself well to be modulated according to the classroom context, as well as to the needs that may emerge during the inquiry. So, there is not one way to implement IBSE remembering that it is “*at its best, an enabling pedagogy rather than a narrow dogma*” (Dillon, 2012)

Having established these premises, we invited the teachers to structure their project in response to their group of students and to the chosen landscape.

Initially, we offered the teachers a general inquiry diagram divided into four phases with a set of key questions each. The complexity of the questions increased as the interpretation of the landscape proceeded (see 1.1, 1.2, 1.3, 1.4 figures). This model has been conceived by adapting the one proposed by E. Rawling (2007) for the investigative approach applied to the study of geography.

Each working sheet shows the different operational steps of the project (in green), a number of examples of possible inquiry questions, and some of the key concepts that allow interdisciplinary work with the Human Geography course. (1.1, 1.2, 1.3, 1.4 figures)



## 1.What?

*Observation and perception / Focussing the study area*



some enquiry questions:

What is the topic or place?

What do I observe?

How do I see it?

How do others see it ?

What is the main question or issue?

*Key concept : space , time scale, cultural diversity.*

Fig. 1.1 - *What?* Inquiry phase.

## 2.What and where?

*Definition and description*



some enquiry questions:

How can the issue or the place be defined/categorised and described?

What is an appropriate sequence of enquiry for this investigation?

*Key concept : space , time scale, cultural diversity.*

Fig. 1.2 - *What and where?* Inquiry phase.

### 3. How and why?

#### *Analysis and explanation*



some enquiry questions:

How did it happen?

Why is this place like this?

What processes are involved?

What people/environment interactions are occurring?

What models might help explain this?

*Key concept : physical and human process , scale, environmental interaction*

Fig. 1.3 - *How and why?* Inquiry phase.

### 4. What might happen?

What impact?

#### *Evaluation and prediction*



some enquiry questions:

What might happen in the future?

Which human and physical process will be in operation?

What trends can be identified?

What are the impacts and consequences?

*Key concept : time scale, environmental interaction, sustainable development*

Fig. 1.4 *What might happen?* - Inquiry phase.

### *Characteristics and run scheduling of the project*

Taking place in the last months of the first year, the project, is implemented through multiple parallel paths:

- the educational one, regarding the different stages of the investigation, in which the teacher provides students with the set of key questions, and a parallel informative one on the morphogenetic processes, in the forms and times that each teacher feels more convenient for the classroom and the chosen subject.
- the educational and informative ones, that the geography teacher will carry out to integrate those by their fellow science teacher.
- the investigative work that students, in groups, will carry out both at school and at home. This involves the use of the Prezi software, intended as a shared workbook, and will culminate in a final multimedia presentation. In this way, students can monitor their own learning process and display it in a final product (DeWitt & Osborne, 2007).
- The project includes one or more field trips, depending on time and access to the chosen site. The timing of the field trip is chosen by the teacher, according to the planning of the project, but it should be preceded by an appropriate preparation in class and followed by a follow-up session to help students secure and better organize the collected data (Orion, 1993).

### *Project implementation and teacher training.*

During the school year 2014-15, the project was implemented in a pilot form with a group of 4 teachers, five classes, for a total of 118 students belonging to 5 classes and three different High schools, namely Liceo Scientifico statale Giordano Bruno (Turin), Liceo Scientifico statale Augusto Monti (Chieri) and Liceo Scientifico statale Norberto Rosa (Bussoleno). This first phase has served to better define the implementation times and managing techniques through frequent meetings with the team of teachers involved (see Fig. 2). Some of these teachers have themselves later become trainers in a specific course for the implementation of the project (see course program in the appendix).

In the school year 2015-2016, the project was then tested a second time, this one with seven teachers, 8 classes for a total of 151 students belonging to other different High schools, namely Liceo Scientifico/Linguistico statale Nicolò Copernico (Torino), Liceo Scientifico statale Piero Gobetti (Torino), Liceo Classico/linguistico Vincenzo Gioberti (Torino). All the institutions from

which the students were sampled are in the metropolitan area of Turin and relative Province, NW-Italy.

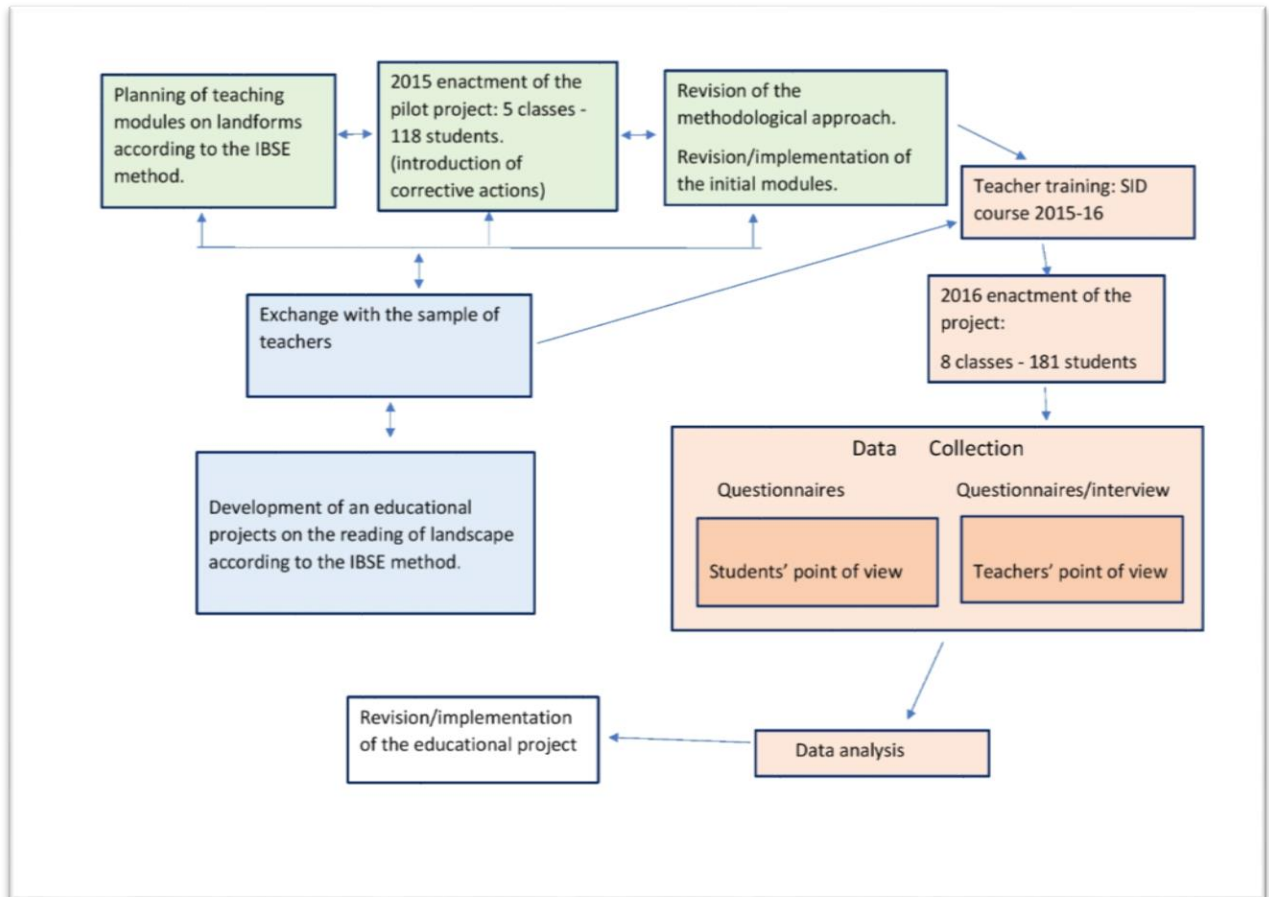


Fig. 2 - Research process flow chart.

### *2016 Project evaluation / data collection*

Quantitative data has been collected through pre- and post- projects questionnaires. The collected data allows to verify the point of view of both teachers and students on the effectiveness of the project and its levels of criticality.

#### *1. Questionnaire for the teachers*

The project was joined on a voluntary basis by seven teachers who had taken part in the SID course (where a total of twenty teachers took part, coming from both middle and high school). The study was designed as an explorative case study since the little scale of the sample.

The first set of questions was functional to define the characteristics of the group of teachers involved. These aimed at understanding:

- Their educational background
- Their years in service
- Their degree of familiarity with the Geosciences subjects taught in the first year, based on their declared habit to teach them
- Previous IBSE method experience in teaching

The goal of the second set of questions was to learn the opinions of the teachers on:

- The training course
- The overall effectiveness of the project, in terms of student cognitive and procedural outcomes
- The efficiency of the project, in terms of the relationships with the students and among the students.
- Any issues / obstacles emerged during the implementation of the project
- The impact of the project on their teaching practice six months after its implementation

## 2. *Questionnaire for the students*

Students were asked to undertake anonymous pre- and post- project questionnaires. The pre-questionnaires were especially devised to collect data on:

- Their degree of interest, predisposition and motivation in Geosciences.
- What they had been previously taught with regards to physical geography.
- Their idea of the discipline and the importance they attributed to it, both in individual and collective contexts.
- The kind of methods and activities they hoped to experience in learning physical geography.

The focus of the post- questionnaires for students was to verify the effectiveness of the project:

- In stimulating interest on the topics covered.
- In creating incentives to the study of the subjects covered.
- In not creating any interference with the study of other disciplines.

## RESULTS

### *Profile of the teachers sample*

The sample of seven teachers involved in the project (*a,b,c,d,e,f,g*), was composed by four female (*a,b,c,d*) and three male (*e,f,g*). What emerged from the first set of questions is that, at the beginning of the project:

- The majority were between 50 and 60 years old (*a,b,c,d,f,g*), with the exception of one teacher (*e*) aged 39.
- The younger teacher (*e*) had less than five years of teaching experience in high schools, while the others had in average more than 25 years of experience in science teaching in High school (Biology, Chemistry, Geosciences teaching).
- Apart from the younger one, who wasn't employed full time, all the others were tenured teachers.
- They all taught in Italian high schools (*Lycei*)

For what concerns their higher educational background (Tab1): among the group, three had a degree in Natural Science (*c,d,e*), three in Biology (*a,b,f*) and one in Geology (*g*). Furthermore, with regards to their predisposition in teaching Physical Geography, the collected data shows that, with the exception of one teacher (*e*), all the others used to spend at least 15% of the annual time in teaching Physical geography. Finally, four of the teachers (*a,c,f,g*) had already experienced the IBSE approach in their didactics (tab 1).

Teacher	<i>a</i> ♀	<i>b</i> ♀	<i>c</i> ♀	<i>d</i> ♀	<i>e</i> ♂	<i>f</i> ♂	<i>g</i> ♂
Degree	Biology	Biology	Nat.Science	Nat.Science	Nat.Science	Biology	Geology
IBSE previous experiences	yes	no	yes	no	no	yes	yes
Time allocation in Physical Geography scheduling before the project							
Sea and oceans	0	1h	0	0	0	2h	0
Wave and currents geomorphic processes and coastal landforms	0	1h	0	0	0	0	0
Wind	2h	1h	0	0	0	1h	0
Eolian geomorphic processes and landforms	0	0	0	0	0	1h	0
River and streams	3h	2h	2h	3h	0	1h	3h
Fluvial geomorphic processes and landforms	2h	1h	8h	2h	0	1h	3h
glaciers	2h	2h	2h	2h	0	0	1h
Glacial geomorphic processes and landforms	2h	2h	2h	1h	0	1h	3h
Landforms from Erosion and Deposition by Gravity	0	0	2h	0	0	1h	0
Landscape interpretation	3h	0	4h	2h	0	2h	1h
% Physical Geography classes in 1 <sup>st</sup> year scheduling	14h/66h 21,2%	10h/66h 15,1%	20h/66h 30,3%	10h/66h 15,1%	0h/66h 0%	11h/66h 16,6%	11h/66h 16,6%

Tabella 1- Project team teachers' attitude in teaching Physical Geography issues.

### *Training course evaluation*

The first questions of the post-project questionnaire, aimed to reveal teachers point of view on the training program. After the project enactment, they were asked to evaluate it on the basis of their personal experience of the IBSE implementation with their students. Results says that the teachers' sample found mostly formative all the training classes with the highest scores attributed to the outdoor training. (Tab.2)

Tab.2 Training course' evaluation charts

Training Course issues	Strongly formative	Formative	Neutral	Weakly formative	N° teachers absent
Landscape-reading: the point of view of Physical Geography	X	XXXX			○○
Landscape-reading: the point of view of Human Geography	XX	XX		X	○○
The teaching of Physical Geography in Italian upper secondary school: from national standards to the introduction of an Inquired Based education approach.	XXX	XX			○○
Lab work: the identification of landscape components	XXX	XXX			○
The reading of landscape: concept and method for an inquired based planning.	XXX	XXX			○
The reading of landscape with IBSE: 2014-2015 classroom experiences report	XXX	XXX			○
A case study analysis for an IBSE project of Landscape reading: Glacial environments in Veny Valley (Mont Blanc massif, NW Alps) and its evolution	XXX	XXX		X	
Lab work: Google Earth as a Geography education tool	XXX	XXX		X	
Lab work: GPS navigation device suitable for smartphone and tablet as education tools for field work.	XXX	XX		XX	
Lab work: The Prezi graphic organizer for presentation as a tool for students' teamworking	XXX	XXX		X	
The application of an inquired approach in the outdoor: Guided fieldtrip in the Turin Hills	XXXXX	X			○

### *Project's outcomes from the teachers' point of view.*

Using a Lickert agreement scale questionnaire we were able to have a more articulate picture of the results from the teachers perspective, but principally to get an idea of how do teachers see the project outcomes. Looking to the results of tab.3, it emerges clearly that the involved teachers have a quite positive perception of the educational effectiveness of the project with the exception of some items which seem to be more controversial.

In particular the perception of the attitude of Italian student toward IBSE due to their learning habits seems to be the most divisive as well as how much Ibse could interfere with the ran of traditional curricular activities.

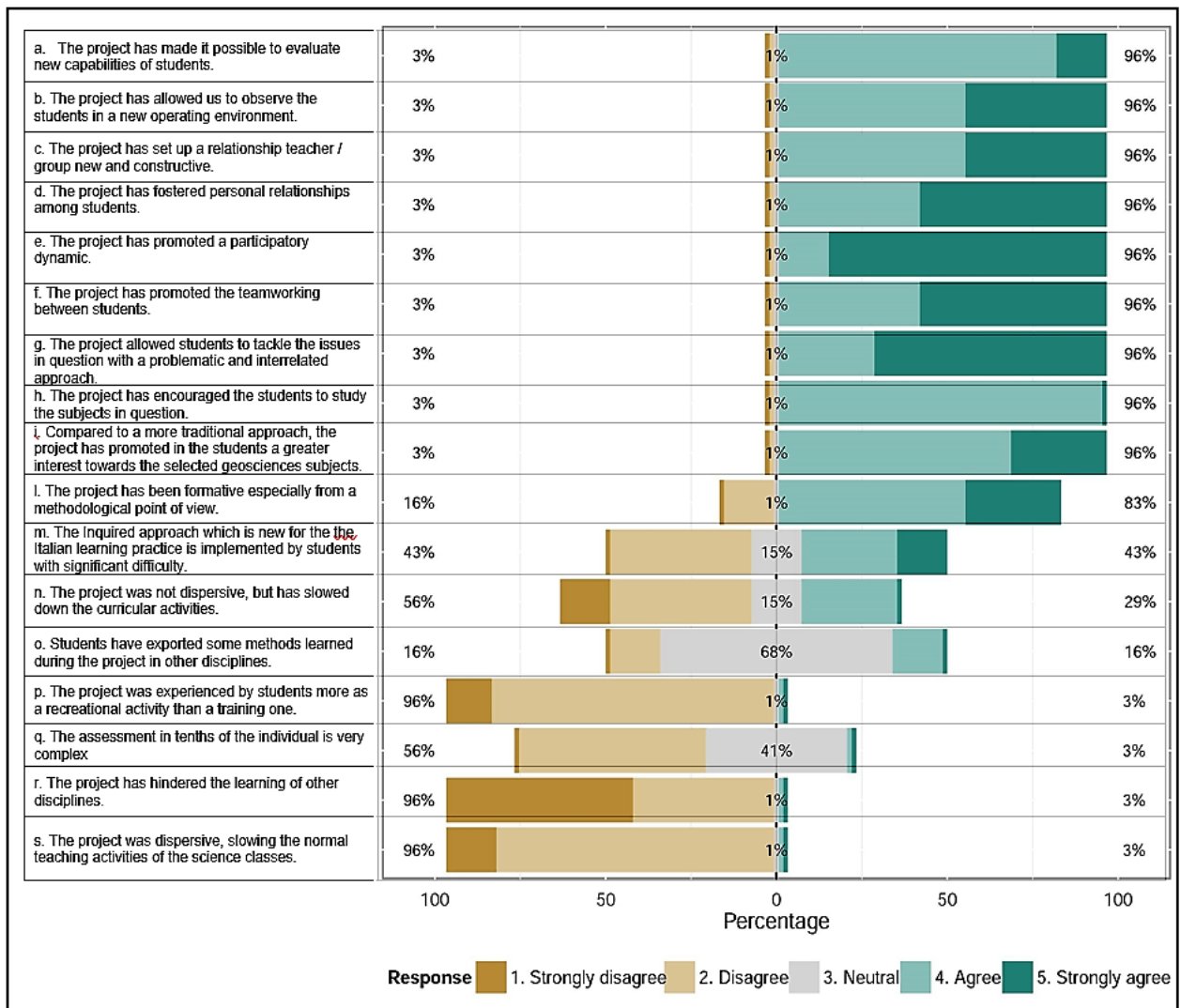


Fig.4 – Project’s evaluation from teachers perspective

Teachers stated also that the engagement of Geography’s colleagues was not that simple, since they succeed in implementing the cross-curricular part of the project in less than half of cases. (Fig.5)

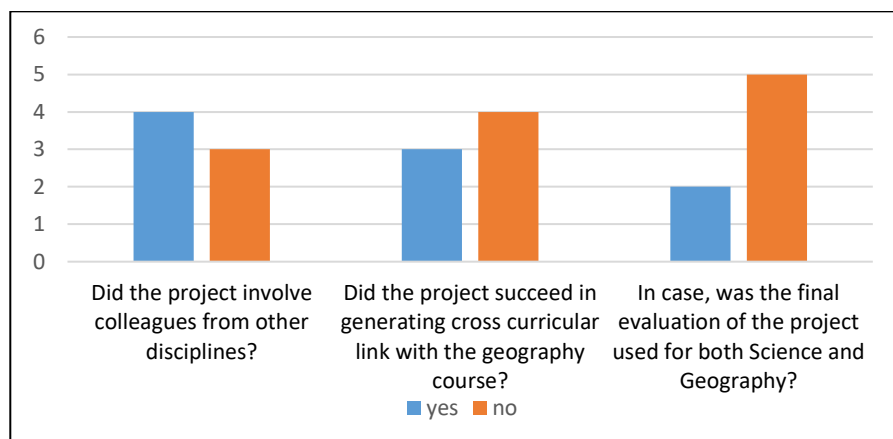


Fig.5 – Cross-curricular goals of the project



Lastly, teachers were asked to indicate briefly which aspects they think were the best of the projects and which ones need to be improved. The field work appears what they have experienced better in four cases while the timing of the project figure to be the part more challenging to manage. (tab.4)

Tab. 4 - The project in short teachers' perceptions.

teacher	BEST ASPECTS	ASPECT NEEDING IMPROVEMENT
<b>a</b>	Posing questions to students; the field work.	The observation of students' work and the observation of teachers' ones.
<b>b</b>	The activity involved the whole group, stimulating interest and curiosity	Time management.
<b>c</b>	The field work.	Let the kids understand that is school even when you are out for a walk among trees and hills, and be able to maintain the balance between pleasure and rigor. Engaging in this process other teachers of the class and of the science departments.
<b>d</b>	The participatory dynamic.	The time management.
<b>e</b>	The inquiry approach .	The use of the GPS device in the field context .
<b>f</b>	The direct and socialized vision of a natural environment.	The timing of the realization of the project (due to the fragmented organization of sciences classes).
<b>g</b>	The field work. Working with Google Earth.	The concept and practice of IBSE itself in the Geosciences domain.

### Summative assessment.

The assessments of the discipline conceptual learning outcomes in function of the Inquire intervention still remain a very complex task as reported by different authors ( Minner et al.2010, Dillon 2012, Dovigo & Rocco, 2013). So we let teachers to freely decide how to plan their assessments methods and how to translate the results in scores.

For what concern the summative assessments of student's presentations, the high variety of projects made it impossible to use a common grid, so we just ask teachers to give us a feedback in terms of student's final outcomes (tab.5).

Tab.5 All of the teachers (a,b,c,d,e,f,g) reported that, in average, student's evaluations met the expectation.

At the end of the year average students' Geosciences learning outcomes :	Exceed the expectation	Met the expectation	Need improvement
		XXXXXXX	

*Student's point of view.*

In parallel to that on teachers, a second questionnaire survey was conducted on their students enrolled in the projects. The pre-project questionnaire was carried out with the aim of investigating the degree of interest, predisposition and motivation in Geosciences developed during the middle school years (subject of the reform too). The results which are widely discussed in a separate work (Sturani, in submitting) revealed a high interest and an appropriate degree of confidence towards Geosciences subjects planned for the first year of high school. Furthermore, when questioned about the methods to deal with the study of Geosciences, the group of students gave their preference to a field and laboratory experimental approach. This was highly regarded in the phase of project design.

For what concern the student's post-project questionnaire, we must say that the collection of data was not that simple and successful. For the pre-project test, by using a web-based survey were collected data from 151 students, which was the 84% of the total sample. For the post-project test, using the same web-based methods only 95 students fully completed the on-line questionnaires, which is only the 53% of the sample. Thus, it is important to say that the results discussed below may not totally reflect the students' point of view on the project.

As for teachers, students' data reveal a quite positive appreciation of the project in terms of the interest and the involvement promoted by the inquiry approach (Fig 6 and 7).

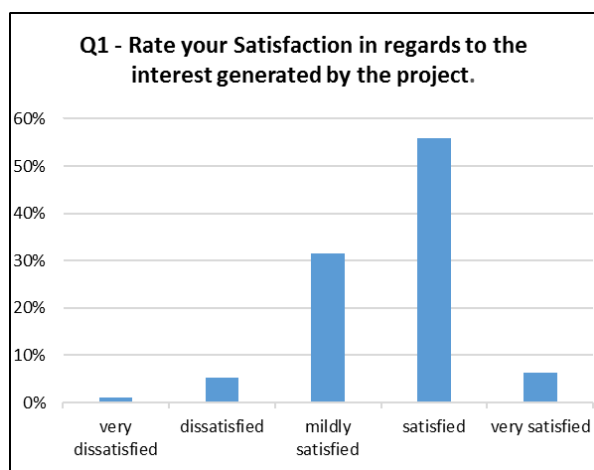


Fig. 6

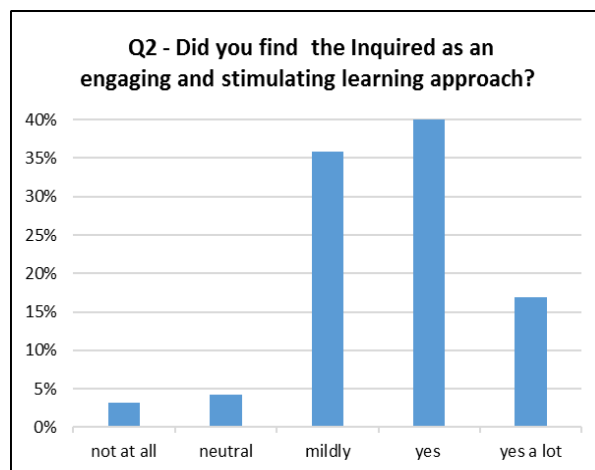


Fig. 7

For what concerns the difficulties they encountered in the implementation of the project, students indicate the field data collection and the focusing of inquiry questions as the more challenging

phase ( fig.8). The sample of students declared also that during the project their point of view have been much valorized (fig9).

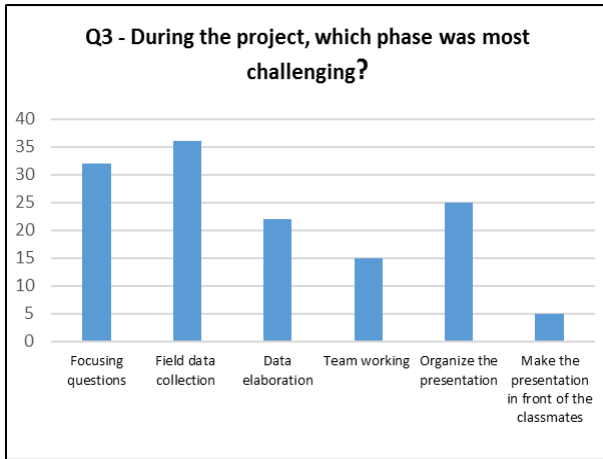


Fig.8

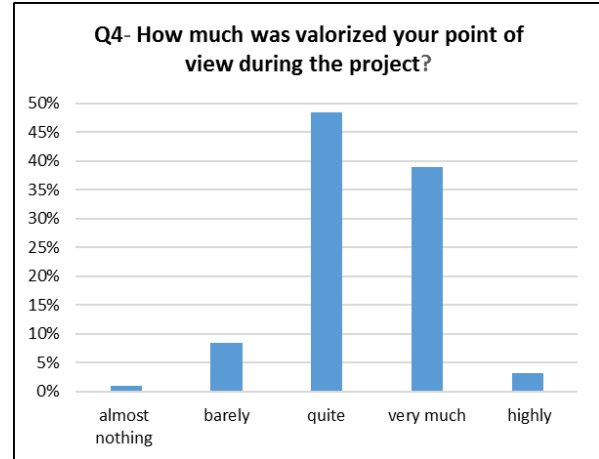


Fig.9

Furthermore, it emerges that students have been encouraged in studying Geoscience by doing the project and the participation did not interfere with the study of the other disciplines. (Fig 10,11)

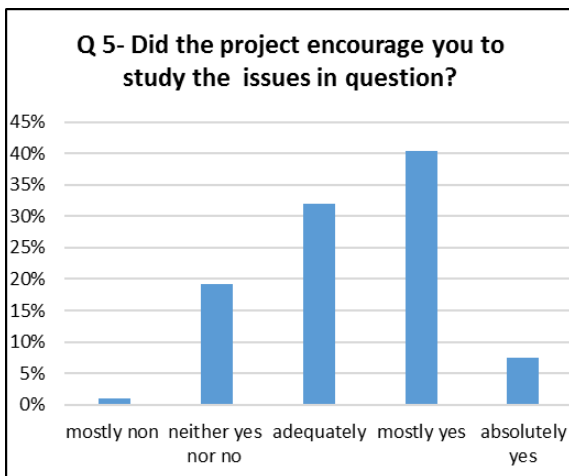


Fig.10

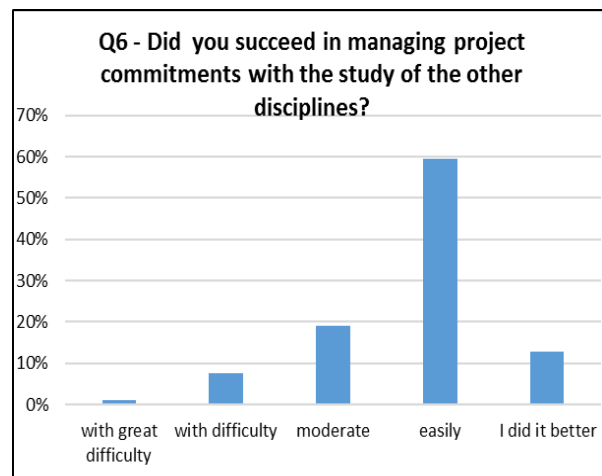


Fig.11

Lastly, students were asked to rate the main features of the project. It emerges a quite positive judgment for the proposed items with a distinct preference for the fieldtrip experiences. (Fig 12)

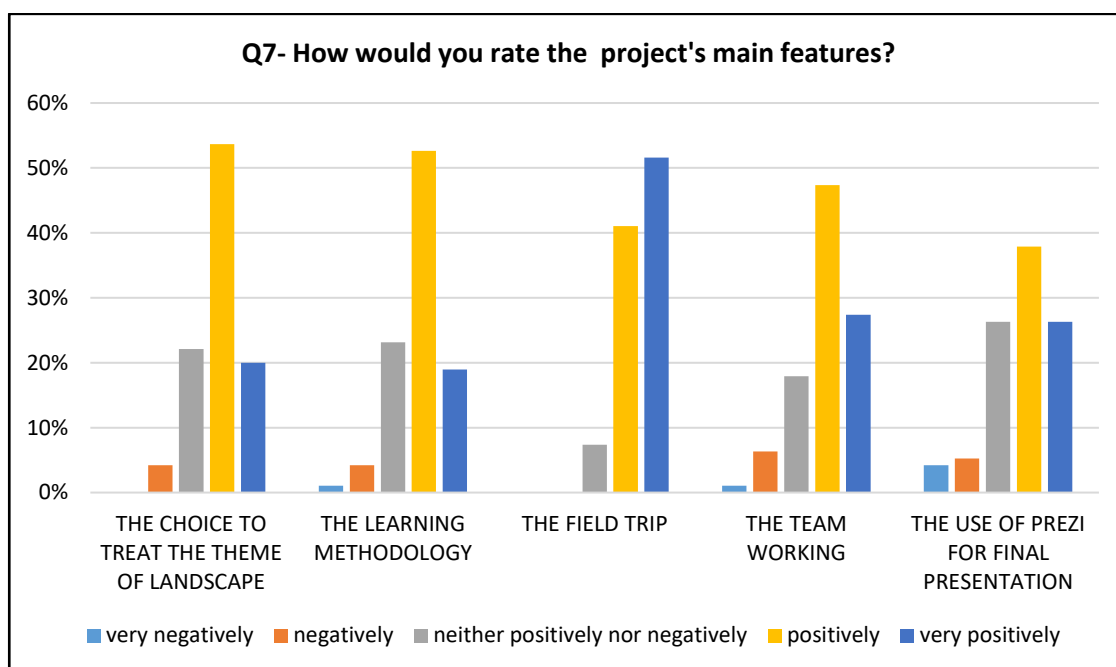


Fig.12 – Project’s evaluation from students perspective.

In order to assess the mark left by the project on teachers’ and students’ habits, we ask teachers two questions six months later the intervention.

Tab. 6 Impact assessment on teaching habits six month after the project intervention.

Months after its completion, can you say that the project left a mark on your didactics and / or your programming of the syllabus for the first year students?	
<b>a</b>	<i>“I will continue using the SID-IBSE methodology, which I started using 4 years ago. Furthermore, this year, in the second semester, as their Geography along with Science teacher, I will organize, together with the History and Religion colleagues, a project for the first year students on the acquisition of certain social skills (collaboration, teamwork, problem solving...)”</i>
<b>b</b>	<i>“Yes.”</i>
<b>c</b>	<i>“Yes, it definitely gave me new stimuli.”</i>
<b>d</b>	<i>“Yes, but since I’m not teaching first year l. scientifico students anymore, I will apply it to the disciplines I teach to students from other years.”</i>

<b>e</b>	<i>“Yes, I have included landscape interpretation in my scheduling, and to make up for my shortcomings I am attending a course on the use of technologies applied to cartography, so that perhaps in the future I can organize a similar activity to that of last year.”</i>
<b>f</b>	<i>“I already used to apply the “inquiry-based learning” didactics to many activities, but taking part in the project has reinforced my already positive opinion.”</i>
<b>g</b>	<i>“This year, I will maintain the approach and the Prezi production with the presentation, but I will search for greater stimuli with regards to the questioning approach and I will try to find two new areas for the field trip. Furthermore, the project has been the object of several productive confrontations with my colleagues in the department. “</i>

Tab. 7 Impact assessment on student’s habits six month after the project intervention.

Months after its completion, can you say that the project left a mark on the students?	
<b>a</b>	<i>“Yes, the students show a greater interest in the Science projects or activities. “</i>
<b>b</b>	<i>“The field experience has definitely left a positive impact, however it would be difficult to organize it again both for the lack of time and because the class council doesn’t easily engage.”</i>
<b>c</b>	<i>“The students have become a little more proactive and less executive.”</i>
<b>d</b>	<i>“Unfortunately, not, because the group of students has undergone radical changes: many students with difficulties (not only learning difficulties) didn’t pass the year, while new students coming from other schools joined the class in September.”</i>
<b>e</b>	<i>“I can’t say, as I no longer teach those students, unfortunately.”</i>
<b>f</b>	<i>“Students now increasingly ask me to implement my teaching with experimental activities.”</i>
<b>g</b>	<i>“The field trip is frequently evoked and the teacher can always make reference to it.”</i>

## DISCUSSION AND CONCLUSION

If we consider the assumptions that have led to the development of this study, in other words the implementation of a teaching strategy that could work as an inspiring and motivating element for a class of teachers little disposed towards treating physical Geography subjects planned in the first year of high school, we have to say in the first place, that the sample of teachers that voluntarily participated to the project cannot be called representative of the category. Almost all the teachers involved was already accustomed to treating the contents point of the study and more than half had previously received an academic training in the Geosciences field (Tab1). Furthermore, four of them had already employed the IBSE approach in their lessons, although not in the Geosciences field.

If these aspects are by some means an obstacle when we consider the representativeness of the sample of teachers, they have been an advantage during the conception of this work and its implementation and while operating single interventions.

The overview of the results of this study gives us some interesting indications over the general impact of this project that however, considering the premises, cannot assume a different feature than a study of exploratory nature. The teacher's judgment concerning the target of the project in promoting learners participatory dynamics, collaborative capabilities and team working is unanimously positive. (Fig 4., tab.4) More so the feedback from the teachers reveals that the project worked as a motivator and has produced a positive impact on their own dynamics of relationship with the class group (Fig4: item c), at the same time permitting to observe single students in a new operative context, therefore under a new light.

This kind of remarks echo those coming from the students that confirm the pedagogical effectiveness of the project, promoting in the collective field active participation and synergistic capacities, and in the individual field promoting an independent point of view. Teachers and students are unanimous in judging the employment of this kind of approach in learning as a promoter of greater interest and inclination towards Geosciences treated topics and a greater stimulation to study these subjects compared to a traditional approach.

However, with the exception of a general data we can visualize in tab 5, due to the methodological difficulties in building a common evaluation' pattern and due also to the uneven quality of available data, we haven't been able to measure the impact that those interest, method and incentive we have detected in our study have on the single student's comprehension levels and acquisition of contents on the disciplinary topics of Physical Geography

In achieving single projects a crucial role has been played by setting up field activities and not only because needed in exercising the capacities of reading landscape or as a fundamental practice facilitating the learning of Geosciences.

Field activities, that were judged as the most educational already during teacher's training, remain in teacher's and student's memory as truly catalyst moments of the whole inquiry process. Following months of time still "*The field trip is frequently evoked and the teacher can always make reference to it.*" (Tab.7)

Considering the project's potential for incentivizing cross-curricular linkage between science and geography courses (classes), from the comparison between the opinion of teachers and data possessed we can say that only a small fraction of cases were really achieved.

This seems to be ascribable to some typical problems that Italian teaching class finds in professional comparison with colleagues. (De Sanctis, 2010). The main obstacle at achieving the project in the whole may be ascribed to time management and it's lack in first year's science timetable (Tosetto 2011, Marini 2012)

Altogether the project data seem to indicate that, to optimize Geosciences teaching at 1<sup>st</sup> year in Italy, the introduction of an inquiry module on the reading of landscape represent a valuable educational strategy.

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**Programma Scientiam Inquirendo Discere - SID Centro Pilota SID Torino**

Sede: **Accademia delle Scienze di Torino**

Responsabile **Alberto Conte** Responsabile didattico del polo: **Silvio Tosetto**

**Attività di formazione dell'a.s. 2015-2016**

**“La lettura del paesaggio: un percorso a cavallo tra scienze e geografia rivolto all'ultima fascia dell'obbligo”**

10/11/15 h. 15-18	<p><b>La lettura del paesaggio dal punto di vista della Geografia Fisica e della Geografia Umana.</b></p> <p><b>L'insegnamento della Geografia Fisica nella scuola superiore italiana: dalle indicazioni nazionali per i licei all'introduzione di un approccio inquirend.</b></p> <p><b>Esercitazione da proporre in classe: la determinazione delle componenti di un paesaggio</b></p>	<p>Intervengono La Prof.ssa <b>Manuela Pelfini</b>, ordinaria di Geografia fisica e Geomorfologia presso l'università statale di Milano e la Prof.ssa <b>Giovanna Merlo</b>, già docente di Geografia Economica nella scuola secondaria superiore e docente a contratto per l'università di Torino per la formazione degli insegnanti.</p> <p><b>Matteo Sturani</b>, docente di ruolo A060, attualmente in distacco per dottorato di ricerca presso l'università di Milano,</p>
19/11/2015 h. 15-18	<p><b>La lettura del paesaggio: Idee e strumenti per una programmazione annuale secondo un approccio inquiry-based.</b></p> <ul style="list-style-type: none"> <li>• le fasi per un progetto</li> <li>• Esperienze condotte nelle classi nell'anno scolastico 2014/2015</li> <li>• analisi di un caso studio: il paesaggio glaciale dell'alta Val Veni nel massiccio del Monte Bianco e la sua evoluzione."</li> <li>• lavoro di gruppo: Impostazione di un progetto di tipo inquirend sul caso studio</li> </ul>	<p>Intervengono i docenti <b>Matteo Sturani</b>, <b>Laura Iguera</b> e <b>Silvio Tosetto</b>, docenti di ruolo A060)</p> <p><b>Gianni Boschis</b>, docente di ruolo A039, attualmente in distacco per dottorato di ricerca presso l'università di Camerino.</p>
26/11/2015 h. 15-18	<p><b>L'utilizzo delle TIC nella didattica della geografia sia in aula sia in campo:</b></p> <ul style="list-style-type: none"> <li>- La didattica della geografia con Google Earth</li> <li>- l'uso di applicazioni per tablet e smartphone (geo referenziatori) da usare sul campo</li> <li>- L'uso di PREZI, per la costruzione di un quaderno d'appunti condiviso e per la presentazione delle ricerche</li> </ul>	<p>Esercitazioni condotte dai docenti <b>Giovanna Merlo</b>, <b>Matteo Sturani</b> e dalla dr.ssa <b>Alessandra Magagna</b> (dottore di ricerca presso l'Università di Torino)</p> <p><b>N.B.: Esercitazioni all'aperto e in laboratorio informatico presso IIS Copernico-Luxemburg C.so Caio Plinio 2 Torino</b></p>
25/02/2016 h. 15-18	<p><b>La conduzione dell'attività didattica sul campo: rassegna dei diversi approcci adottabili</b></p> <p>Lavoro di gruppo: studio di fattibilità e progettazione di un'uscita sul campo per lo studio del paesaggio</p>	<p><b>Matteo Sturani</b></p>
10/03/2016 h. 14-17,30	<p><b>La didattica della geografia fisica sul campo: Uscita sul terreno</b> in collina di Torino con mezzi pubblici (da Pian del Lot a Cavoretto). Uscita facilmente replicabile per tutti gli ordini di scuole.</p>	<p><b>Laura Iguera</b>, <b>Matteo Sturani</b> , <b>Silvio Tosetto</b></p> <p><b>N.B.: ritrovo h 14,00 a Torino, piazza Vittorio Veneto alla fermata del bus 70</b></p>

Gli incontri avverranno, salvo diversa comunicazione, presso la Sala Vallauri dell'Accademia delle Scienze, in Via Maria Vittoria 3 Torino dalle ore 15.00 alle 18.00

## 7. GENERAL DISCUSSION AND CONCLUSION

Regardless of the opinion one might have on the 2011 secondary school reform, it can not be denied that it has introduced some elements of innovation in science teaching, and in particular with regards to Geosciences in the Italian secondary schools.

However, the results of this thesis, together with those of some works carried out in parallel, have highlighted that, even though these were not prescriptive, teachers were confronted with a substantial difficulty in making the national guidelines operational, particularly with regards to the Geosciences curriculum. As a consequence, to date this discipline is marginalized and neglected in the Italian teaching practice, especially in the first year of secondary schools.

Rather than experimenting new Geosciences educational modules, overall the Italian science teachers, who in average are among the oldest in Europe and predominantly have a biological background, seem willing to maintain their long-established choices in their course planning, even when these are no longer in line with the national guidelines.

Within this framework, the authors and publishers who in the past, while awaiting the reforms, were the first ones to introduce new educational paradigms through innovative approaches in their textbooks, have now in most cases, so as not to dissatisfy the current demand of the teachers, conceived textbooks with an encyclopaedic approach – which allows a wide and free choice of topics on the one hand, but lacks a didactic approach in line with the guidelines for the first year on the other.

In the author's opinion, this is a further element that played a role in the non-consolidation of the cultural identity of Geosciences within the curricula of the new Lycei.

Albeit limited to a case study, the landscape reading didactic experiment, connecting the Science and Geography syllabus in an interdisciplinary way, has, however, shown that when treated with an inquiry / investigative approach and connected to one another (and not with a mainly content-descriptive approach), the Geosciences can work as a driving force and be strongly motivating for both the teachers and the students.

The encouraging results that have emerged from the experiment suggest that further researches should be conducted in this direction so as to disseminate the inquiry approach in the Geosciences didactics, in order to promote and strengthen the cultural identity of the discipline and have its formative value emerge in all its potential in the reformed school.

## 8. CONFERENCE PAPERS

SGI-SIMP Conference “The Italian Geosciences of the future, the future of the Italian Geosciences”  
– Milano, 10/09/2014 – 12/09/2014

**Abstract (Poster Presentation)**

Le Scienze della Terra nei libri di testo della scuola secondaria di secondo grado italiana: cambiamenti ed evoluzione.

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<sup>1</sup>Dipartimento di Scienze della Terra, Università di Milano

I libri di testo nella scuola secondaria di secondo grado continuano a rappresentare uno strumento imprescindibile a supporto dell'attività dei docenti e dei discenti per una corretta acquisizione di abilità e competenze. Nell'ambito di un progetto di dottorato in Scienze Ambientali, presso l'Università degli Studi di Milano, sono in corso ricerche finalizzate all'analisi dei libri di testo di Scienze della Terra disponibili sul mercato e, in dettaglio, sui testi attualmente in adozione in un ampio campione di scuole (licei scientifici e classici), distribuito a scala nazionale. I primi risultati mostrano come nell'ultimo ventennio si è assistito a un incremento significativo dell'offerta editoriale per quanto riguarda le Scienze della Terra. Ciò può essere posto in relazione con i mutati quadri orari e spazi dedicati a tale disciplina nel corso del quinquennio degli indirizzi liceali, imposti dalle varie proposte di riforma, e da come autori ed editori hanno interpretato le indicazioni che accompagnavano tali direttive ministeriali. L'offerta editoriale appare particolarmente ampia e differenziata a partire dall'a.a. 2010-2011 anno in cui, nel liceo appena riformato, le tematiche relative alle Scienze della Terra compaiono nei programmi già dal primo biennio. Nei titoli stessi termini come *Sistema*, *Gaia* prendono il posto dei tradizionali *geografia*, *geografia generale*, e compaiono verbi come *osservare*, *capire*, *scoprire*, a supporto di un approccio più sperimentale. Il progetto di ricerca si estenderà quindi all'analisi di dettaglio del campione contenente i titoli più comunemente adottati, in termini di contenuti, struttura, organizzazione, apparato iconografico e in termini di impatto/efficacia delle diverse impostazioni, in relazione alle indicazioni ministeriali, su un vasto campione di studenti.

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# Le Scienze della Terra nei libri di testo della scuola secondaria di secondo grado italiana: cambiamenti ed evoluzione

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(1)

Dal settembre del 2010 il nuovo quadro normativo, previsto dalla riforma, ha introdotto nella scuola secondaria di secondo grado notevoli cambiamenti nell'insegnamento delle Scienze Naturali.

La novità principale riguarda la riduzione dei quadri orari settimanali in tutti gli ordini di scuola (istituti professionali, tecnici, licei linguistico, artistico, delle scienze sociali) fatta eccezione per i licei scientifico tradizionale e classico per i quali il numero delle ore è aumentato, le scienze sono inserite fin dal primo anno e viene introdotta la verticalizzazione dei curricula (Biologia, Scienze della Terra e Chimica in parallelo fin dal primo anno). Con l'anno scolastico 2014/2015 si conclude il primo ciclo di secondaria post riforma.

Il presente lavoro rappresenta la prima fase di un progetto di ricerca, e ha come obiettivi principali:

- L'analisi dei prodotti dell'editoria scolastica al fine di verificare come questa abbia interpretato le indicazioni della riforma relativamente alle Scienze della Terra per il primo anno dei licei classico e scientifico
- L'analisi del peso relativo di ogni macro argomento all'interno di ogni titolo
- L'analisi delle risposte della classe docente osservabile attraverso la selezione dei testi operata con le adozioni.



(2)

Le note che accompagnano il decreto di legge (D.P.R. n°89 del 15/3/2010) per l'attuazione dei programmi di Scienze Naturali dei nuovi licei comprendono: *Linee generali e competenze e obiettivi specifici di apprendimento.*

Nelle prime il principale elemento di novità è l'importanza che viene data all'approccio sperimentale nella pratica didattica e l'invito al ricorso di attività in laboratorio/campo per tutto il percorso formativo, mentre per gli obiettivi specifici di apprendimento relativi al primo biennio di studi, le Indicazioni sono:

«Nel primo biennio prevale un approccio di tipo fenomenologico e osservativo-descrittivo»

Per le scienze della Terra si completano e approfondiscono contenuti già in precedenza acquisiti, ampliando in particolare il quadro esplicativo dei moti della Terra. Si procede poi allo studio geomorfologico di strutture che costituiscono la superficie della Terra (fiumi, laghi, ghiacciai, mari eccetera)(sic).

[...] Fatti salvi i contenuti di scienze della Terra, che andranno affrontati nella prima classe e sviluppati in modo coordinato con i percorsi di Geografia, i contenuti indicati (chimica e biologia ndr) saranno sviluppati dai docenti secondo le modalità e con l'ordine ritenuti più idonei alla classe, al contesto anche territoriale, alla fisionomia della scuola e alle scelte metodologiche da essi operate».

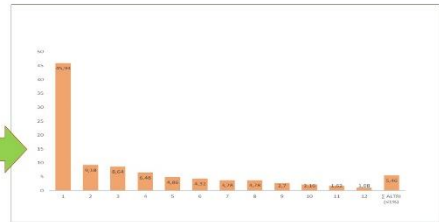
A partire dal 2011, dopo un primo anno "sperimentale", vengono messi a catalogo titoli per l'insegnamento delle Scienze della Terra nel biennio dei licei.

(3)

Attualmente a catalogo e disponibili per le classi prime vi sono oltre 400 titoli, comprese le vecchie edizioni e i testi per le classi superiori\*. Nel campione esaminato ne risultano adottati sessanta nei licei scientifici e quaranta nei licei classici. Tale varietà si riduce tuttavia a circa un quinto in entrambi i casi; molti titoli corrispondono a edizioni multiple della stessa opera che si differenziano per la presenza di estensioni (es.chimica) o di materiali aggiuntivi o per la versione digitale.

Il 94% del campione è coperto da circa una dozzina di titoli. Questi sono i medesimi nei due tipi di licei salvo alcune differenze nelle percentuali di adozione e con l'eccezione del testo più diffuso che corrisponde a oltre il 40% in entrambi i casi.

\* Dato Associazione Italiana Editori



Dall'analisi degli elenchi dei libri di testo adottati per le classi prime disponibili on line è stato ricavato un campione di adozioni (licei scientifici e classici) corrispondente alle scelte di oltre trecento licei distribuiti in tutte le regioni scelti in modo casuale (dati relativi ai licei scientifici). Nella tab.2 e nel grafico soprastante vengono presentati i dati dei licei scientifici.

Table with 2 columns: Titolo, Data di testo. It lists various textbooks and their publication dates.

Tab.1: i nuovi quadri orari dei licei

Table titled 'TESTI PIU' DIFFUSI NEL CAMPIONE ESAMINATO' with columns for title, author, and percentage of adoption.

Tab.2 : testi più diffusi nel campione

- La maggior parte dei testi (9/12) propone quasi tutti i macrotemi considerati
- In tutti i testi, pur escludendo la parte relativa ai moti della Terra, figura una significativa parte dedicata all'astronomia (cosmologia, planetologia)
- Diversi testi (8/12) dedicano un ampio spazio alla geologia e/o alla climatologia
- Tutti i testi propongono una sezione di geomorfologia generale;
- 2/12 evidenziano un percorso di lettura del paesaggio.

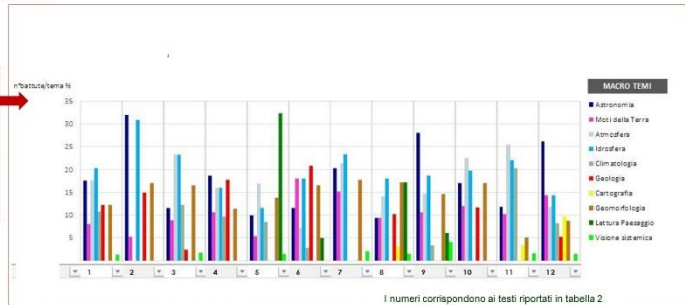
Il campione analizzato evidenzia come la trattazione di alcuni argomenti quali la geologia s.s. o la climatologia segua una collocazione temporale diversa dalle indicazioni ministeriali; ad es la geologia s.s. è prevista a partire dal secondo biennio, la climatologia al quinto, l'astronomia attualmente non è prevista. Facendo riferimento al quadro normativo è interessante notare che sebbene geografia fisica e geomorfologia siano trattate in tutti i testi, solo una minoranza segue in modo esplicito un percorso guidato alla lettura del paesaggio con un coordinamento alla geografia generale.

(4)

Se il nuovo quadro previsto per Scienze della Terra rappresenta una significativa opportunità di innovazione nell'ambito della prassi didattica di questa disciplina, i risultati sinora ottenuti mostrano come ci sia la tendenza a conservare scelte di insegnamento assodate nel tempo. Gli autori scelti in prevalenza sono quelli caratterizzati dalla più lunga presenza sul mercato.

Quanto all'ampio spettro di argomenti presente in tutti i testi, vale considerare che se da un lato consente la libera creazione di percorsi formativi, dall'altro penalizza la lettura di un disegno logico complessivo.

La quantità di argomenti infatti è decisamente superiore alla possibilità del loro svolgimento in relazione al numero di ore disponibili



L'analisi dei dodici testi più adottati al primo anno dei licei è stata fatta sulla base di diversi indicatori che tenevano conto, tra gli altri, dei contenuti affrontati, dello spazio dedicato ad ognuno all'interno del libro, qualità e numero di fotografie/illustrazioni, strutturazione logica dell'opera. Nel grafico si mostrano i dati relativi allo spazio dedicato a dieci macrotemi.

AAVV, "Critical Analysis of Science Textbooks Evaluating instructional effectiveness", VII, 312 p., 34 illus. Kluwer, Mym Sww (Ed.) 2014  
Davis, K. S. (2003). Change is hard: What science teachers are telling us about reform and teacher learning of innovative practices. Science Education, 87(1), pp. 3-30. doi: 10.1002/ese.1007  
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**Abstract (Poster Presentation)**

Pre service teachers attitudes toward planning and scheduling geo-field trip at secondary level: a case study.

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II. Dipartimento di Scienze Giuridiche C.Beccaria- Università degli Studi di Milano

The field trips are considered widely powerful methods of learning in all Natural Science and Geography but is in the domain of Earth-Science learning where they play a core role. Since field trips are a way to integrated classroom to real world, benefits from field activities are various moving from a deepest comprehension of knowledge to the acquisition of specific skills and abilities (2,3).

Despite this, recent papers evidence a general decline of field activities in Earth-Science courses for primary and secondary schools. Lack of time, increasing costs, logistics and strong safety protocols are some factors which strong demotivate the teachers to plan field activities. Nevertheless some authors pointed out that, among others, an important limiting factor depend by “the unfamiliarity with conducting field trips and the lack of curriculum materials relevant to field trip(3). In view of the above, fieldwork training should play an unavoidable step in pre-service teaching Earth -Science program. Only a small number of studies focus on the attitude of pre-service teacher towards fields activities (1) but there are no reports that gives an idea of the effectiveness of the training program on novice teacher’s skills and abilities in scheduling, managing and conducting field trips. For this reason the basic aim of this research is to measure - in a sample of Italian pre-service secondary teacher science program (TFA/2015)- either their prerequisites and previous attitude towards fieldtrips activities either the effectiveness of the program in enhancing teachers ability in planning field trips.A first analysis of the fieldtrips proposed by the novice teachers evidences difficulties both in the organization and in the teaching approaches, greatly conditioned by previous personal experiences. In most of the cases a traditional “teacher centered “ approach is adopted instead of an inquiry based one. Even if the analyzed sample is small, in relation to the number of dummies used, this work represent a first step towards a significant deepening.

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# Pre service teachers attitudes toward planning and scheduling geofield trips at secondary level

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2. Dipartimento di Scienze Giuridiche C.Beccaria - Università degli Studi di Milano



One week geological field trip in Lanzarote - Spain. Liceo scientifico statale «P. Gobetti» di Torino - Italy. Foto Carolina Bottisio.

«Students could view slides of a dune and investigate quartz grains in the laboratory, but it is only by climbing the steep front slope of a sand dune, that a student could receive a direct sensory-motor experience of learning about the structure of a dune». (Orion, 2003).

## INTRODUCTION

The Field Trips are considered widely powerful methods of learning in all Natural Science and Geography but is in the domain of Earth-Science learning where they play a core role.

Since field trips are a way to integrated classroom to real world, benefits from field activities are various moving from a deepest comprehension of knowledge to the acquisition of specific skills and abilities.

Despite this, recent papers evidence a general decline of field activities in Earth-Science courses for primary and secondary schools. Lack of time, increasing costs, logistics and strong safety protocols are some factors which strong demotivate the teachers to plan field activities.

But this could depend also because few pre-service teachers experience field trips in their previous science classes and so remain unaware of the potentiality the outdoor environment can provide.

In view of the above, in this research we wanted to measure in a sample of Italian pre-service science teachers (TFA - classe A060) their attitude toward planning and scheduling geo-field trip and the potentiality of Italian territory for this purpose. In particular we tested three hypothesis: 1) Is there any correlation between preservice teachers academic background and their exam score? 2) Is there any correlation between pre-service teacher's experience as student and their attitude in planning field trips? 3) Can we measure the educational potential the Italian territory can provide?

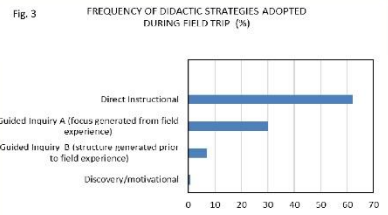
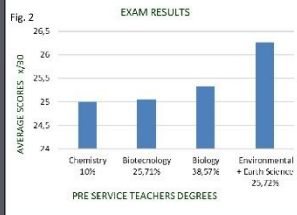
## METHODS

Seventies pre-service science teachers were asked to produce a field trip lesson plan for high school class after a Earth Science Teaching Training Course (TFA) by using a fixed format (Fig.1). Location, duration, type of school and all didactic strategies were freely definable. These plans were the final course test.

For the evaluation three primary indicators were considered:

1. General feasibility (logistics, safety, costs, time scheduling, location potentiality)
2. Didactic coherence (between educational goals of trips and annual scheduling)
3. Didactic feasibility (coherence between educational goals of trips and planned didactic strategies)

The seventies formats constitute the analyzed dataset.



## RESULTS

### Evaluation of trainees (Fig.2)

Trainees were divided in four categories in relation to their degree. The results shows an average score of 25/30 for Chemistry graduates who represent the 10% of the trainees sample; the same score 25,05/30 was reached by Biotechnology graduated (25,71%); A little better score 26,27/30 gains Biology graduated (38,57%) while 26,27/30 is the better average score reached by the category which aggregate Environmental Science and Geology graduated (25,71%). This category also shows the maximum number (5) of top scores (30/30, 30/30 cum laude).

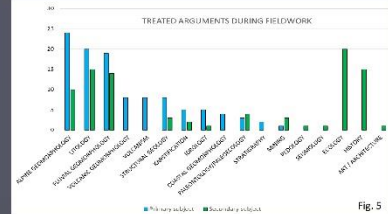
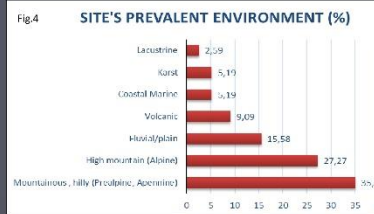
### The choice of field didactic strategies (Fig.3)

With reference to the didactic strategies planned by trainees, the results show that in very few case the students would gain the outdoor activities in a discovery/motivational way (2/70). In average a guided inquiry with focus generated from field experience covers a 30% of plans, while in the majorities of case, over 60%, plans were dominated by an instructional/descriptive teacher's leading style.

### The educational potential of Italian territory (Fig.4/5)

The sites selection shows a dominance of Lombardy's locations since the Earth Science training course was ran in the University of Milan. This would explain why Mountain and Alpine environments are prevalent but ten Italian regions were covered with seven different geomorphological environments (Fig. 4). Due to the environment variety, the trainees succeeded in treating twelve different Earth Science topics relevant for the curricula. Ecology, History, Art and Architecture are also explored with significance as cross-curricula opportunities. (Fig. 5).

Field trip lesson plan format			
Laboratorio Didattico di Scienze della Terra - Via ZCivico 4054/3060 / Università di Milano			
Autore: <input type="text"/> Nome: <input type="text"/>			
Field Title: <input type="text"/> Overall aims: <input type="text"/>			
Location: <input type="text"/>		Reference map: <input type="text"/>	
Motivational issues:	Curriculum link:	Type of high school:	Time slots in annual scheduling:
Expected learning teacher/ students:	Learning objectives:	Didactic strategies:	Learning materials:
Transportation arrangements:	Cost/person (€):	Itinerary length (km):	Approx. distance (h):
			Duration of the trip (h):
			Number of scheduled breaks (duration):
Description of the site: Is it suitable for the intended purpose? Is it safe? Is it accessible? Is it interesting? Is it educational? Is it motivating?			Is there a field club in the student's residence? Is it possible to achieve?
Annual scheduled contents (topics):		Cross-curricular opportunities:	
Preparation class activities to field trip:			
Materials/ issues needed:	Supply of and equipment needed (data collection, safety): 1 collective ? individual		
Description of field activities:	Time allocated:	Description of the environment (climate, soil, vegetation, biotic resources, weather, student experience, educational objectives, pedagogical / motivational):	
Student's experience assessment:	Teacher's activity assessment:		



## DISCUSSION

### Evaluation of trainees

The first hypothesis which individuate a correlation between trainees degrees and scores seems not to be confirmed due to the very low variability between the results. So firstly we can say that the specific skills and abilities achieved during tertiary education, aren't designed in the prospective of teaching in high school. Secondly the results suggest that teaching is not the first best choice of a Science graduated who probably presume to spend his competence in different working domains. This suggest that a more designed curricula for science teachers at academic level is needed. Lastly we can say that graduated in Environmental Science who shows an higher frequency of top scores (30/30 and 30/30 cum laude) seems to be more ductile to achieve the didactic skills requested by the teacher's profile.

### The choice of field didactic strategies

If we compare trainees results, especially if we consider their proposals in terms of didactic feasibility (fig.3), it appears clear that the experiential learning approach is not part of "candidate's DNA". In the majority of case (60%) the planned outdoor activities are leaded by teachers in an instructional/descriptive style; only in one third of plans presents an inquiry approach while in very few case was adopted a discovery/motivational one. Once again this reflects the Italian didactic practice which is traditionally teacher-centered. Even after the training course, which focus on student-centered activities, candidates use to replicate their previous experience as students.

### Italy's landscape variety

The locations of plans show as how rich and versatile is the Italian territory for field trip realizations (fig.4). The educational potential is proportional to the extremely high variety of the existing environments. As shown by results the quasi-totality of topics relevant for High school science-curricula are touched either as primary subject either as secondary ones in the presented plans (Fig.5). Nevertheless the learning goals of such a versatile territory are not limited to Earth Science ones since they could be extended to those of Geography, Economy and Citizenship education.

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**Abstract (Poster Presentation)**

Urban geoheritage as a resource for Earth Science education: examples from Milano metropolitan area.

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Fieldwork and field activities have been recognized as key experiences in fixing knowledge, acquiring competences and skills for enquiring based approaches in Earth Sciences education (King,2006). Field experiences may be addressed to the discovery of geodiversity and geoheritage representing great opportunities for students to observe and analyze the landscape they live in (Magagna, 2016). Nevertheless many are the possible problems for outdoor lessons and activities related to traveling distances, economic implications, access limitations, insurances and in particular the annual hours for science lessons. In this framework big towns, small cities and also villages, differently inserted in the landscape, offer great opportunities for Earth Science education through an interdisciplinary approach including among the others: history, literature, art and also chemistry, physics and physical education. Urban geoheritage is becoming a new tool in cultural heritage and recent researches outlines the magnificence of Italian towns (Pica et al.2016)). Moreover urban geoheritage represents a great opportunity in teaching activities for different targets: children, students and also for teachers. A practical example comes from the formation experience for secondary school teachers carried out by UNIMI among the activities of TFA (Training for acquiring the qualification for the profession of teachers at the high school level). An itinerary in the city center of Milan, supported by a procedure for collecting lithological data observing buildings and street floors, becomes the instrument to move the attention from urban artifacts to the provenance sites (e.g., caves and mines) located all around the Northern Italy (and sometimes abroad) to open to the geology of the Italian Alps. A new “hydrological” itinerary is being developed, inside the “Cerchia dei Navigli” (the ring of streets where navigable canals were present until early XX century) is being developed and will allow to know the different hydrographic features of Milan during the past times, when fluvial geomorphology was more evident and when water ways were common. Moreover, subsurface data will allow the analysis of the contribution of superficial and ground-waters and of the works and infrastructures for water management in shaping the current urban landscape.

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Field activities have been recognized as key experiences in fixing knowledge, acquiring competences and skills and in "enquiring based" approaches in Earth Sciences education. Field experiences may be addressed to the discovery of geodiversity and geoheritage representing great opportunities for students to observe and analyze the landscape they live in. Nevertheless many are the possible problems for outdoor lessons and activities related to traveling distances, economic implications, access limitations, insurances and in particular the yearly hours amount for Science lessons.

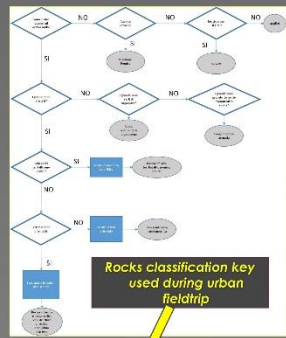
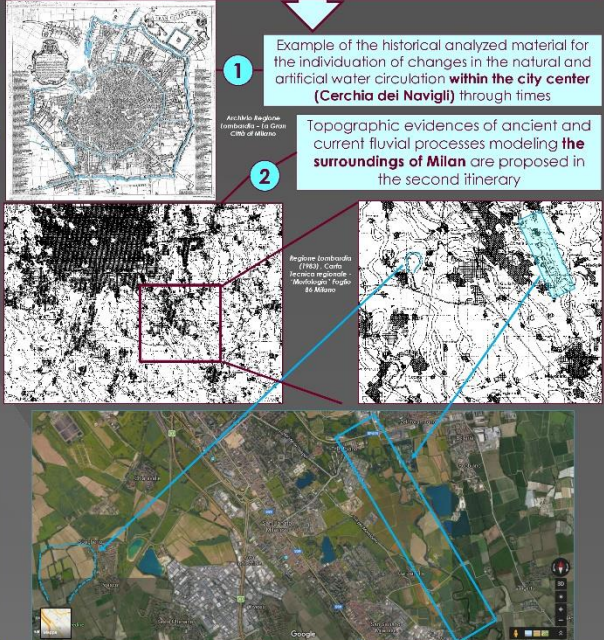
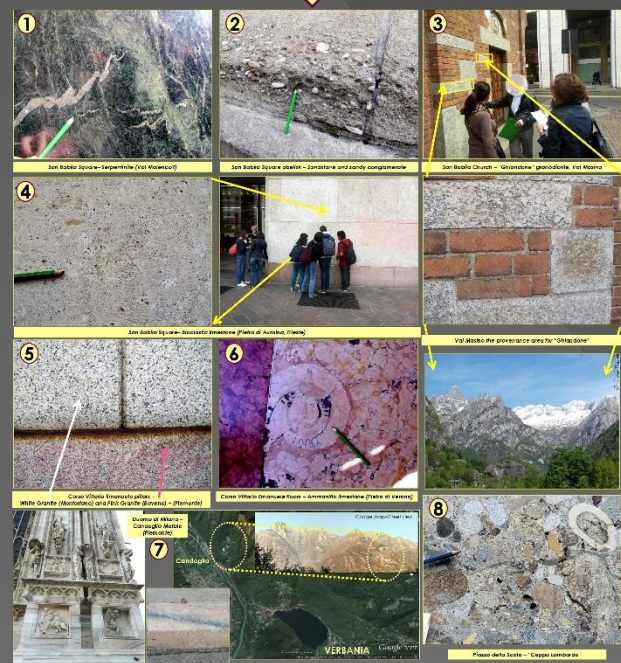
In this framework big towns, small cities and also villages, differently inserted in the landscape, offer great opportunities for Earth Science education through an interdisciplinary approach including among the others: history, literature, art and also chemistry, physics and physical education. Urban geoheritage is becoming a new tool in cultural heritage and can take advantage from the magnificence of Italian towns. Moreover urban geoheritage represents a great opportunity in teaching activities devoted to different target audiences: children, students and also teachers.

A practical example comes from the formation experience for secondary school teachers carried out by Università degli Studi di Milano among the activities of TFA (training course for acquiring the qualification for teaching at the high school level). An itinerary in the city center of Milan, supported by a procedure for collecting lithological data observing buildings and street floors, becomes the instrument to move the attention from urban artifacts to the provenance sites (e.g., caves and mines) located all around the Northern Italy (and sometimes abroad) to get in touch with the geology of the Italian Alps.

New "hydrological" literacies are being developed in Milan metropolitan area

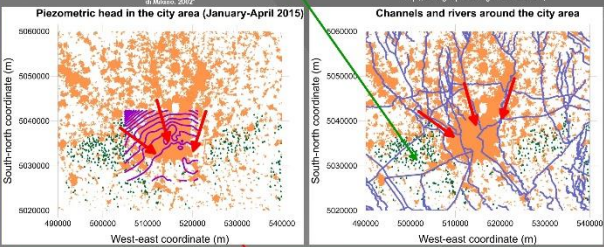
- 1 inside the "Cerchia dei Navigli" (the ring of streets where navigable canals were present until the early 20th Century);
- 2 in the surroundings of Milan searching for landforms deriving from current and ancient fluvial modeling by topographic evidences analysis.

"Water itineraries" will allow to recognize the different hydrographic features in Milan. The goal is to help in recognizing, in the present-day urban landscape, the geomorphological elements modeled by both natural and artificial processes: fluvial geomorphology & anthropic geomorphology. Water ways have been modified during the history of the City, since the Roman Age, through Middle Ages, Renaissance, Modern and Contemporary Ages. Particular attention will be paid to the effects of water management (water works and sewage networks, artificial channels etc.)



The selection of key sites will permit to highlight:

1. The **natural role of water** in modeling landscape;
2. The **role of water infrastructures** (channels, sewage and aqueduct networks, etc.) in changing the landscape;
3. The **interaction between surface and ground water** in correspondence of rivers and channels and of flowing wells ("fontanilli"; **green dots** in the map on the right).



It is worth to be noticed the **convergence of surface and groundwater flows towards the city center (red arrows)**, as an effect of:

- a. the **control exerted by water infrastructures on rivers** and channels reaching the city from the North;
- b. the **concentration of pumping stations in the city area**, which caused a depression cone in the aquifer and a converging groundwater flow towards the city center.

**DISCUSSION:** the two educational activities focus on urban geology and geomorphology.

- The one related to petrography and lithic materials used for city buildings and related links from the center of Milan to the Alps was tested with apprentice teachers. Some of them successfully repeated the experience with school students, and this demonstrates that field activities, which can be realized closely to schools, might be a valid opportunity for increasing knowledge in Earth Sciences.
- The second one regarding fluvial geomorphology in urban contexts is "under construction" and the two itineraries will be tested soon with teachers and students. It might represent a good example not only to familiarize with urban geomorphology, but also to introduce students to applied problems such as management of water resources and flood hazard and risk analysis

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## 9. PUBLICATIONS

### 9.1 PUBLISHED MANUSCRIPTS:

- I. STURANI M . (2016)- Teaching Physical Geography in Italian High Schools (Licei): current situation and perspective, Rend. Online Soc. Geol. It., Vol. 40 (2016), pp. 91-98

### 9.2 ACCEPTED MANUSCRIPTS FOR PUBLICATION

- I. STURANI M., PARRAVICINI P., PELFINI M., (accepted with revision). Pre-Service Teachers attitudes in planning and scheduling geofield trip at secondary level: a case study, Rendiconti Online Della Società Geologica Italiana .
- II. PELFINI M. , BOLLATI I. , GIUDICI M., PEDRAZZINI T., STURANI M. & ZUCALI M. (accepted with revision). Urban geoheritage as a resource for Earth Science education: examples from Milan metropolitan area. Rendiconti Online Della Società Geologica Italiana .

### 9.3 MANUSCRIPTS IN PREPARATION FOR SUBMISSION:

- II. STURANI M., MAMMOLA S., PELFINI M., (in submitting) Student's Geosciences awareness at the beginning of Upper Secondary School in Italy: a case study on the impact of in and out of the class experiences, International Journal of Science Education.
- III. STURANI M., PELFINI M., (in preparation for submission). Introducing Inquiry approach to Geosciences teaching in early High School: a pilot science education project in north western Italy, Journal of Research and Didactics in Geography (J-READING).

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