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Maps, Earth Apps and Land Images: Different Tools for Different Skills

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Abstract

An analysis carried out on first (11-14) and second grade (14-18) Italian secondary school students and an in-depth analysis carried out in recent years, during the in the different stages of regional and national selections of the Earth Sciences Olympics, and particularly with the students participating in the learning week organized for who will make up the Italian team of the IESO -International Olympiad of Earth Science, highlighted widespread difficulties in the analysis of topographic maps.

The decreasing diffusion of geography teaching in Italian schools, the increasing use of digital tools, apps and software, such as Google Earth and navigators, free and easy to use, has made the use of the topographic maps, and of the various thematic ones, among the students, substantially obsolete.

If the use of digital tools has promoted digital skills, ease of orientation, even greater security in discovering new places, it is leading meanwhile to the loss of skills of observation, analysis and understanding of the context, that only the view of a large area included in a map and not in a few inches of a screen, can give. In reality, both resources constitute a formidable tool, not only for the discovery and knowledge of the territory, but for the growth of specific skills, which are crucial for the knowledge of a territory, but also indispensable in scientific research. In this research we analyse tools, models and pathways, which foresee the integration of the two resources, and which skills their integrated use can implement.

Introduction

I started this research because I have always been passionate about cartography. The old maps of the Italian Military Geographic Institute, inherited from my grandfather who patiently glued them onto the canvas, so that they could be preserved for longer, the geological maps of my university studies, the planispheres of the Touring Club, precious historical documents, have allowed me to "travel", before I actually did, with my mind.

The digital revolution, in this as in many other scientific fields, has overwhelmed and disrupted the field of cartography, and with it the fields of research that use it, geography, Earth sciences, topography and spatial planning: Google Maps and Google Earth, GIS technologies, or simply TomTom navigators, have made possible to forget paper maps, impractical and even anti-historical.

We certainly do not want to question the advantages that these tools have brought: speed, precision, effectiveness in graphics and quality in reproduction. Traditional and even obsolete tools, such as paper maps, the large sheets of paper on which many of us have studied, analysed, interpreted and coloured, have been fully passed by digital tools, bitmap images, aerial and satellite photos, digital maps, raster graphic, which make possible to superimpose infinite data, to digitise them, to pass rapidly from one layer to another, from 2D to 3D images, building models and simulations of immediate visibility. These digital bases have made possible to overcome the precious, but tiring and even tedious work that has seen many researchers, geographers, geologists, patiently colour by hand, with the rigorous tones of the Pantone palette and a lot of patience, the maps derived from their studies: a job that few people regret.

But it is also true that, as often happens, the acquisition of new

tools can facilitate and speed up many works, but it can also lead to the loss of certain skills, sometimes necessary, often useful, never superfluous.

The aim of this research is to relate, in the educational field, advantages and disadvantages of teaching and using different tools such as paper maps and new technological applications, especially in relation to the different skills and competences that may be acquired from their use.

Analysis of the contest

The study of cartography in Italian schools is normally assigned to the teacher of geography. The use of maps is in fact the basis for knowledge of the territory, the foundations on which the complex competence of the geographer are based: from the Atlas of Profession, "the Geographer studies and represents the organisation of a territory in its dynamic, human and physical aspects; and, else he analyses the processes and methods by which a given portion of the earth's surface assumes a specific configuration according to the different relationships that are established, in historical periods, between man and the environment. "What is a geographer?" asked the Little Prince. "He is a wise man who knows where the seas, rivers, cities, mountains and deserts are," replied the old gentleman (from The Little Prince by A. De Saint-Exupéry).

In fact, a quick glance at the National Indications for the Secondary School from the Italian Ministry of Education, shows that geography should include the teaching and reading of geographical and topographical maps: main forms of graphic representation, as ideograms and histograms, and cartographic, as physical, political, thematic, topographic and topological maps, concepts of travelling distance, economic distance in terms of time and costs, geographical grid, geographical coordinates, latitude, longitude, altitude, time zone. But more should be dedicated to recognising the transformations made by man on the territory, using maps and images, and to analyse the most significant themes (anthropic, economic, ecological, historical) using various sources, to analyse, through direct/indirect observation, a territory, to know and understand its organization, to identify aspects and problems of human-environment interaction over time.

In a tourism vocational high school, a school sector with a particularly interest in the knowledge of own local environment, the Ministry programs request to recognize the geographical, ecological, territorial aspects of the natural and anthropic environment, the connections with demographic, economic, social and cultural structures and the transformations that have occurred over time; to understand the interdependence between economic, social, institutional, cultural phenomena and their local/global dimension; to establish links between local, national and international cultural traditions both from an intercultural perspective and for the purposes of study and work mobility and, finally, to recognise the value and potential of cultural and environmental assets for their proper use and enhancement.

But in Italy, in the recent years, the Ministry of Education, as a consequence of the latest secondary school reforms, has abolishing or reduced to a few hours of lessons the study of geography. We must admit, moreover, that in the past, at least in many Italian schools, the teaching learning of geography was focused on a mnemonic and notional study of capitals, mountains, rivers, lakes, borders. This study sometimes required a lot of effort to remember these names, and sometimes little tricks and word games, but gradually made this discipline unattractive and uninspiring, although I personally believe that knowing not only the physical characteristics but also the names of its towns, mountains and rivers, the location of faraway countries and even the names of their capitals has a significant cultural value, in addition to being a good mental exercise. The discipline suffers from the use of a traditional, not investigative educational approaches, full of data to be memorised and too often the work of the teacher, who sometimes do not have adequate preparation to teach this discipline in a conscious and professional manner. As consequence, it appears as an anti-historical discipline, aseptic with regard to a critical reading of the territory and the dialogue between environment and man, detached from the past and the present, but above all far from the educational needs required by the 2030 Agenda, which calls for curiosity in learning, mental flexibility and the ability to identify and build relationships, characteristics and skills that a future World Citizen must possess.

The result is that the geography, and particularly the teaching learning of cartography, that allows to know new territories, new cultures, to 'discover' new worlds, even if only in our own minds, and to imagine great journeys, now that the media have reduced distances and allow to everybody to interact with people living on the other side of the Earth, has lost its identity: it is now occurring is a gradual shifting to a fictional and transversal discipline whose contents are now intertwined with those of other disciplines. Knowing how to read, observe and analyse different types of maps are abilities no doubt necessary in many other disciplines: in history they are needed to understand the expansion of the Roman Empire, the route and therefore the importance of the Silk Road, the discovery of America or the gradual conquest of the West; they may be indispensable in the study of Earth sciences, to understand plate tectonics theory, and finally topography or land surveying cannot be developed without a topographical basis. (Fig.1a-b-c)

Figure 1:-a The route of the East India Company - 16th century

Figure 1:-b The conquest of the West -19th Century

Figure 1: -c Plate tectonics map -20th Century

Figure 1: -a,b,c examples of maps, to be used as base for different disciplines

Analysis of The Tools

Obviously the focus of this research is not the teaching learning of geography but the analysis of the tools of the geographer, whether researcher or teacher, student or simply user, the comparison between different instruments, ancient and recent, trivial or technological, and mainly the skills that can be acquired through their use, if any, whether they are different in relation to the different tools and therefore, if so, the importance of the different instruments being taught and used. From a strictly disciplinary point of view, the reading of a topographical base, whatever the instrument, map, software, app is used, pursues very clear and basic cultural and scientific objectives: to orient on the ground with compass, to "read" the landscape, to interpret and recognise the complex phenomena which are represented ton a map and the factors that influence them, or vice versa to report phenomena and data on the cartographic "dump" base, no matter in graphic or digital shape, as a result of personal analysis on the ground or one's own interpretation of the phenomenon.

This study has tried to analyse how students' skills have evolved, from the use of the cartographic tool, to digital tools, now widespread everywhere. It attempted to check whether this passage, which is as fast as all the technological transformations that are affecting schools and the world of knowledge, has led, or not, to greater competence in reading the landscape, in the ability to orient in unknown territories, be they undisclosed cities or excursion routes.

The study has tried to investigate whether a geographic map, in its inconvenience and impracticality of use, which a gust of wind can mess up, has really lost all its educational value: absolutely aware of the wealth of information that any software can contain, has anyway sought to analyse whether the use of a screen of just a few centimetres limits the ability to contextualise the area examined in a wider territory, compared to what happens when using a large sheet of paper representing the same space.

The different tests carried out aimed to compare the results of knowledge related to the use and reading of a topographical map, a typical map of the Italian Military Geographical Institute, It is a basic tool, yet often little known: with several tests we tried to understand in the average or excellent student, selected in national tests, what raw data the students, in the different grades of schooling, are able to read, what exercises they are able to tackle, what skills the practice of these exercises can develop, what specific competences can be built up and what can be transferred to other disciplinary contexts. Similarly, some tests were carried out using a geological map, "a sheet of paper full of meaningless coloured spots", as it was described by a frightened student involved in the Earth Science Olympiad: in addition to the obvious, but not always easy to interpret, scientific, geological, structural, stratigraphic, geomorphological information, we tried to see if reading this particular map allows the student to develop specific skills that can be transferred to other contexts.

From the analysis of the results some considerations were derived, presenting some cases and an analysis carried out on a small but nevertheless significant sample of students and an indicator of a trend.

We also tried to understand whether the use of new digital tools, in particular the mobile phone, the most widely used tool at all levels, can totally replace the use of maps and charts or, more simply, has allowed the growth of different skills and competences. A number of examples on the use of cartography are presented, some trivial and well known, others more specific, but all tried and tested, the focus of which, remember, is not the information that the different tools, maps, software or apps contain, but the skills and knowledge needed to be able to use it and above all what competences can be derived.

The Identification of Targeted Competences

It is not easy, among the various sources, to identify which skills, knowledge and therefore competences should be prioritised in the teaching-learning process of scientific disciplines, both the more general ones and those transversal to natural sciences, biology and earth sciences, in particular with reference to the use of cartography.

A brief excerpt of the skills which, together with the knowledge of the disciplines concerned, can lead to the acquisition of certifiable competences at the end of a school course with a scientific vocation, usable both in subsequent studies and in working practice, is proposed, extrapolating from numerous examples and models:

- To observe, describe and interpret natural objects, phenomena, even complex ones, and models by breaking them into

simpler elements,

- To identify characteristic elements in a system, recognising and establishing relationships, making logical connections,
- To formulate hypotheses on the basis of defined data and drawing conclusions from the obtained results,
- To read, construct and interpret different data sources: graphs, thematic maps, diagrams, maps or models.
- To use the textbook and other tools consciously: atlases, specialist dictionaries, databases, web sites, integrating critically the information obtained,
- To assume a conscious and responsible behaviour towards the environment in relation to the problems of risk and resources, in particular as a consequence of the use of exhaustible and renewable resources.

Among the many different competences that at national and European level, also related to the 2030 Agenda, were identified those that are more directly and immediately related, but also more transversal to cartography and its applications, in order to verify if these can be developed more easily or mainly through the use, reading and interpretation of maps rather than through applications and different digital GIS tools, or both, and with which different effectiveness.

The transition from knowledge to skills, different tools

Every schoolbook that deals with cartography normally includes some basic topics such as the definition of a map, a representation of the territory, which must be reduced, thus dealing with the concept of scale, approximate, which requires illustrating the concepts of equidistance, equivalence and isogonia, and symbolic, in which the graphic symbols are presented. Sometimes also the different types of projections are proposed, such as Gauss and Mercator, more often the different types of thematic maps. It is evident that without basic knowledge it is extremely difficult to use those skills that may be inherent in every student, such as being able to observe, recognize and analyse: if the student does not know what to observe, line, graph, object, shape or surface, it is difficult to develop the skill and transform it into a competence.

The teacher should be able to involve and passion the student, showing how a map can help to understand known territories, but above all distant and unknown ones, it provides knowledge of a space without seeing it directly, it allows us to understand the reasons that have produced a certain human intervention in the territory, with different forms and methods in time and space, and in direct relation to the political structure, the economic system, opportunities and physical conditioning.

Historical maps and skills

An historical picture of the evolution of cartography has been proposed, with examples of great interest, as the most famous, the Peutingerian Table and the Planisphere of Juan de la Cosa, telling us about discoveries, travels, conquests, trades, elements sometimes evident, sometimes hidden among picturesque images, mythical characters, geographical naivety. The careful observation of these historical maps fascinates curious minds, but at the same time stimulates the imagination of the difficulties that the cartographer had to face in drawing up these maps, following the explorer or listening to his narrations, with the limited tools he had at his disposal in the different periods. which allow scientific, fantastic, adventurous narratives. (Fig.2a-b-c-)

Figure 2-a The Tabula Peutingeriana, named after the humanist Konrad Peutinger, who came into possession of it in the 16th century. It dates to the 3rd century A.D. with subsequent updates in the 4th and 5th centuries. The scroll is a copy from the 11th-13th centuries. The original is kept in the Österreichische Nationalbibliothek in Vienna.

Figure 2-b Planisphere by Juan de la Cosa, cartographer, explorer and pilot, the first boat map to represent the coasts of the American continent – Naval Museum of Madrid [Public domain]

Figure 3-c Map of Gerardo Mercatore , 1569, Nova Et Aucta Orbis Terrae A geographical deception

Figure 2-a,b,c, Historical maps , used to enhance students' skills

Careful reading of historical map has enabled students to understand the environmental context in which the peoples settled, whether the land was flat, whether the climate was mild, whether there was water, etc. A shared discussion has developed the knowledge that many political events that had their origin in geographical aspects, as conflicts for the possession of territories rich in natural resources or for places in a strategic military or commercial position.

In a kind of treasure hunt, have gradually been unveiled observation, analysis, the discovery of direct, or sometimes unpredictable, relationships, even that a map has been an instrument of power. Mercator's map, a formidable tool for the years in which it was made, is in fact, in relation to the projection that conveniently shifts the line of tangency from the Equator, producing surfaces and shapes that until a few decades ago decreed the geographical as well as the political and economic "superiority" of the northern hemisphere

Once the map has been 'contextualised', placed in the historical period and geographical area, it allows the student

- To observe, describe and interpret natural objects, phenomena, even complex ones, and models by breaking them into simpler elements,
- To identify characteristic elements in a system, recognising and establishing relationships, making logical connections.

Topographic Maps and Skills

A basic topographic map contains, as well known, countless pieces of information, but requires certain knowledge. Some are basic notions: concepts of orientation in space, even just placing the cardinal points correctly, the use of a compass, the ability to read and interpret a contour line, a distance or an altitude. Then we have tried to improve the ability to abstract from a two-dimensional image to a three-dimensional vision, not necessarily precise and detailed as a section might be, but also, simply, a perception of space, if flat, open or irregular, of the height of a mountain or the depth of a valley, the concavity and convexity of a slope, the steepness of an outcrop, the way a watercourse flows.

The image, in black and white, and only rarely with coloured shades, does not help, sometimes it bores, and certainly hardly ever arouses curiosity or enthusiasm. And yet it contains so much information, and perhaps just because of its unattractive appearance, it requires the student brings into play all the skills needed to observe, recognise and interpret the territory.

The reading of the map allows this basic knowledge, i.e., that of being able to decode space, in terms of analysis and valorisation of the topographical components but also in terms of a critical reading of man's choices, because space, with time, constitutes one of the two fundamental categories for man's action in the centrality of the anthropic territory, allowing the student

- To observe, describe and interpret natural objects, phenomena, even complex ones, and models by breaking them into simpler elements,
- To formulate hypotheses on the basis of defined data and drawing conclusions from the obtained results,
- To use the textbook and other tools consciously: atlases, specialist dictionaries, databases, web sites, integrating critically the information obtained.

Switching from Paper to Device: Related Skills

In reality, whether the map is a sheet of paper or an image on a large PC screen, little changes: it is not the device that matters, but rather the ability to grasp all the information that can be extracted from the image.

The student remains, as he should be, the protagonist of the action, using his skills and exploiting all his knowledge; no longer simple lines or shapes, but different levels of information and insights that the complexity of the computer allows to use.

The approach was neither easy nor immediate, also because the use of computers is often considered by students to be easier and more friendly than it actually is, but by formulating appropriate guiding questions or analysing cases it was possible to build a method of comparison, build relationships between different tools, arousing stimuli and curiosity. The comparison between a topographical and a thematic map, for example a map of risks and disasters, allowed the students to formulate, obviously with different levels related to their age, interesting connexions and to start building simple models: the effect of the slope of an outcrop, through the observation of contour lines or the presence of vegetation cover in relation to landslides, the shape of a watercourse in relation to the presence of potentially floodable areas.

The result was the promotion of skills such as:

- To use the textbook and other tools consciously: atlases, specialist dictionaries, databases, web sites, integrating critically the information obtained,
- To formulate hypotheses on the basis of defined data and drawing conclusions from the obtained results,

but also, to make them understand the limits and potentialities offered by this mode of representation

The Transition to Photography and Satellite Imagery: Related Skills

The transition from paper to aerial photography or satellite images was profoundly different and the results of the tested tests deserve further study. The use of photography, from drone, aerial, satellite, on paper or screen, passing from one device to another, from a 2D image to a 3D image, both with photogrammetry and with Google maps, requires an analysis apart, because the skills required grow with the complexity of the tool while the skills are often difficult to acquire, despite the fact that they are fascinating tools, rich in information and increasingly easier to acquire.

It would seem much easier to work on these tools, because an image is closer to our perception, the landscape is real; even in its virtual representation, objects, houses and streets are clearly identifiable and recognizable.

The impact, therefore, both in the case of a 2D image, a sort of Abbot's Flatland, and in the three-dimensional perception, enhanced by the vertical exaggeration that characterizes aerial photography,

is certainly less shocking than the 'colour-spotted' sheet of a representation of the geology of the same area.

In fact, it emerged that, even using the same scale, it is much more difficult to read the details in an aerial or satellite photo than on a topographic map.

Many different cases and tools have been experimented.
Satellite photos, obviously of sufficiently known locations, were the starting point to thrill the students; subsequently, the observation of aerial images was proposed: it emerged, predictably and unequivocally, that if we remove the toponymy and the viability from these images, the students were completely disoriented, in the true sense of the word, therefore not only confused, but even without orientation.
Finally, a comparison between places, shapes and environments of a topographic map and an aerial photo was proposed, obviously of exactly the same area and at the same scale. Nonetheless, this has often proved to be an extremely complex exercise, with unsatisfactory results.

In general, however, in the presence of very simple cases or after a shared analysis and discussion of the landscape, the comparison between the topographic map and the aerial photo can be useful in order to verify the interpretative correctness of the symbols and their correspondence with the real landscape, especially as regards the evolution of the territory, the different types of habitats, crops, land use, etc.

Great interpretative difficulties emerged from the use of aerial photos with the use of the stereoscope, certainly more effective than the 3D image of Google Earth, but which requires a practice that is not suitable for school times.

In general, these tools that have allowed students to acquire skills

- To use the textbook and other tools consciously: atlases, specialist dictionaries, databases, web sites, integrating critically the information obtained,
- To identify characteristic elements in a system, recognising and establishing relationships, making logical connections

Examples of experimented practical activities: first data

Various tests were experimented with students of different ages, with the aim to verify their ability to read a map, to recognise the details of an aerial image, to grasp phenomena and to relate them with landscape forms, with the complex objective of verifying their abilities, promoting and correlating knowledge and skills, then building competences and finally, correlating them with the use of different tools.

Several problems have been posed, at times trivial, at times complex, structured and experimented in relation with the age of the students; interesting results have emerged, even if in numerically irrelevant but still representative samples.

The first level of comparison was between a topographic map and an aerial photo, representing the same area, approximately at the same scale and obviously with the same orientation. In this case, the presence of some evident details, for example a town, allowed a good number of students in the sample to recognize in the image (photo or satellite representation) the elements of the territory that they had been called to identify: a river, a mountain, a particular structure of the territory, demonstrating a sufficient capacity for observation and correlation.

Instead, inevitably in the presence of less structured types of instruments, with different or indefinite scales, a common element of aerial photos or satellite images, among thematic maps, with few exceptions, they were able to recognize the shapes or aspects of the territory that they were called to identify. With a topographical basis of unknown territory, only a few were able to correctly position the cardinal points, despite all being aware of them in theory and perhaps in the natural environment.

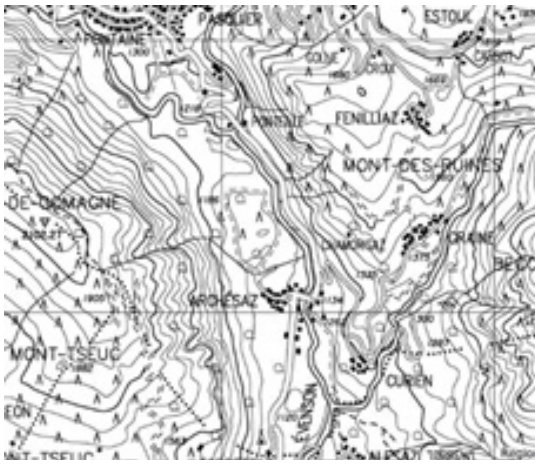

Figure 3-a Topographic map

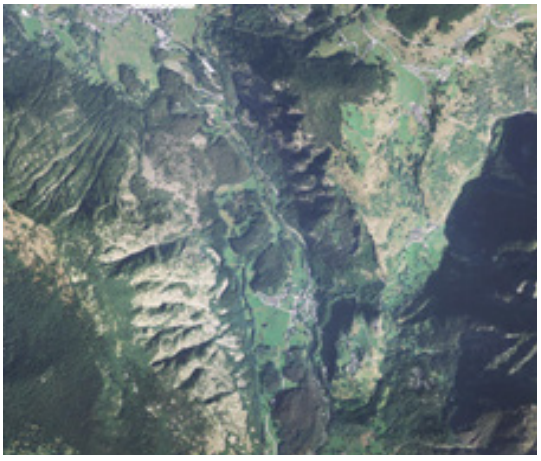

Figure 3-b Aerial Picture 2012

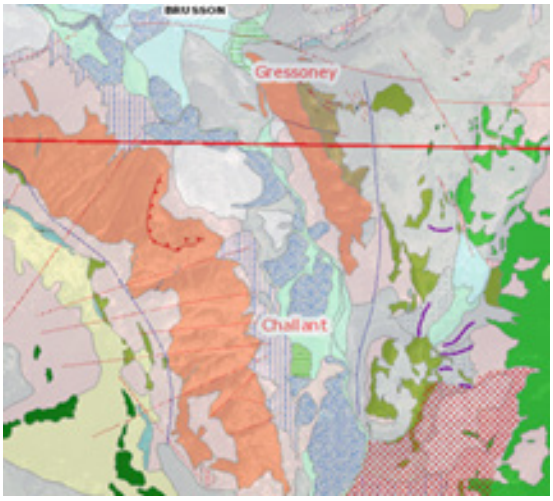

Figure 3-C Geological map from CTR 2005]

Figure 3-a,b,c maps of the same area , in the Aosta Valley – Italy

Several other questions challenged groups of students, regardless of age: which side of the mountain was steeper, where the river was shallower, which path was easier to follow to connect two localities, for example in relation to the heights, slopes and possibly to the variously uneven morphology. (Fig.3a-b-c)

We then moved from simple observation-analysis to the interpretation of phenomena and the criticalities naturally increased, even among older students: the recognition of a particular shape, for example the body of a landslide, a watershed or a morphological ridge had time and support required.

Finally, driving questions were proposed such as whether from one defined place it was possible to view another, even at a short distance or the shapes of the territory, for example an intervening mountain, did not allow it or why the northern slope of a mountain was less steep, in the presence of glacial phenomena.

The skills required were, again:

- to be able to read, construct and interpret different data sources: graphs, tables, thematic maps, diagrams, maps or models.
- to identify characteristic elements in a system, recognize and establish relationships, establish logical connections.
- to formulate hypotheses based on defined data and draw conclusions from the results obtained.

From Active User to Passive User

Finally, we wanted to experiment with the most widespread instrument, your mobile phone, to use maps or satellite images with the aim of obtaining information, road maps, itineraries.
In this case, the classic behaviour of the student is repeated when the whole web is available: whether it is Wikipedia or any other site, it is much more frequent that the text is copied, extracting sentences, without modifications, without interpretations, without above all evaluating his reliability and consistency.

The same happens when using apps: we can type the address, read a route, look at the line that guides us, follow the arrow that leads us to our destination, listen to the voice messages and if we are on the wrong way, it recalculates the route, all spreading the few centimetres of the screen with two fingers as needed.

We do not want to deny the usefulness of the tool for searching the route, as well as the use of the web for any information. The consequence of the increasingly widespread use of this tool, however, is inevitably the loss of observation and analysis skills, the lack of responsibility in choices, a reversal of roles, from actor, operator to passive user. A comfortable and effective tool, but destined to lose the sense of complexity, the ability to understand a complex system, such as the territory, to limit observation to the particular: the motorway exit, the one-way street, the deviation.

From The Centrality of Man to The Complexity of the Territory

Unfortunately for many students the idea of 'reading' the territory through its graphic representations, topographic and thematic maps, but also aerial or satellite photos, in the absence of a solid discipline to guide them in this direction, is increasingly taking shape the use of apps available on mobile phones or on the web: easy to use, fast in providing information, according to many, infallible.
These are undoubtedly convenient and accessible tools, but as often happens, their use goes beyond the acquisition of the skills identified as priorities and which all the other tools proposed are instead able to promote overall, even if in different forms.

The worrying aspect in the use of these apps and the mobile phone is that, as with all technological tools, it tends to replace those tools that have instead proved useful for understanding the concept of complexity that characterise the environment that surrounds us and that, as all-natural components, is made up of a complex system of shapes, structures and relationships.
Those few square centimetres of screen put the individual at the centre, even of the screen, but not of the environment, limit the perception of the context, prevent us from really understanding what surrounds us.

And they certainly do not help to promote the fundamental competence, in the vision of the 2030 Agenda, of the student as a citizen of the world, towards which the study and use of cartography can do much, and has not yet been highlighted:

- To assume a conscious and responsible behaviour towards the environment in relation to the problems of risk and resources, in particular as a consequence of the use of exhaustible and renewable resources.

First Conclusions

From the results, presented here as qualitative, but quantitative data of the tests carried out are being acquired, on the use of different tools for the study of cartography, some considerations emerge, however quite obvious, relating to the use of the different tools and acquired skills. The knowledge of a territory requires first and foremost the knowledge of cartographic elements, both direct: the topographic or thematic map is used to know the territory and its characteristics, and indirect: the information that the territory provides us can be usefully transcribed on a map that can be enriched.

The study of the territory can be done through all the different tools available, topographic and thematic maps, aerial and satellite photos, in the different devices and even through mobile phones. All these tools, if used through a teaching-learning process that goes beyond notionism and pure memorization, which promotes investigation, critical thinking, which uses guided questions, succeeds in thrilling and intriguing, no matter which discipline is in charge., but the means and the ways in which it is proposed.

Through a careful and targeted use of the different tools, both for teaching and testing, it allows the promotion of students' skills and the acquisition of disciplinary and transversal skills. The use of topographic maps is in a certain sense preparatory to the use of technologies, just as the study of multiplication tables is preliminary to the use of the calculator.

All the tools, with the exception of the mobile phone, have proved to be effective in the growth of skills, but only an integrated use of all the tools favours the acquisition of the concept of complexity. From this derives the understanding of the infinite relationships of flow, of cause and effect, of space and time, which link the different components of the environment, of which man is a part and protagonist, but not necessarily at the centre.