# THE INTRODUCTION OF GIS AND GPS THROUGH LOCAL HISTORY TEACHING IN PRIMARY SCHOOL

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## Abstract

Taking into consideration the fact that every place has a number of sites which are worth visiting because they are connected to the local history, we decided to motivate the pupils of 4th, 5th and 6th grade of a small village in Western Macedonia, Greece, in a kind of a treasure hunt (fieldtrip) enriched with the use of compass, GPS and GIS generated maps. The results of the project show that the use of high technology is feasible even from the age of 10, provided that the lesson plan is well designed. High technology applications, like GIS and GPS, can be easier implemented through interdisciplinarity. Finally, a geography related questionnaire was provided to the pupils at the end of the project which showed that the improvement in geography issues was up to 94% among the pupils and in some cases approached the ultimate success compared to the lack of previous knowledge.

*Keywords: geomedia, GIS, GPS, local history, map reading, primary school*

## 1. INTRODUCTION

GeoInformation science and technology is used for spatial interactions. It draws on insights from, among others, computer science and landscape while geospatial technology, such as GPS and aerial photography, is used for geovisualization (output of the data stored by using GeoInformation) (Tsou and Yanow 2010). Gardner (2004) described eight intelligences, one of them being the spatial. These intelligences are activated by using GIS through reading of linguistics, mapping through spatial analysis and analysis through mathematics (Goldstein and Alibrandi, 2013).

It is stated that local applications of GIS enable students to complete in-depth study of local issues and conditions (McGlurg and Buss, 2007) which, in our case, are

focused on local history. The idea of this project was taken from the primary school text book "Study of the Environment" of the 4th grade and was enriched by adding geographic media (or geomedia; Donert 2012) generated by the use of GIS and GPS. The same authors stated that this technology (GIS and GPS) has become more available in 5th through 12th grade. This is a 2007 statement which seems that it is not valid anymore. In our project this technology was used by the pupils of 4th grade (10 years old) of the primary school of Agia Paraskevi, Kozani, Greece.

Moreover, GIS incorporates fieldwork (Louv, 2006) even in primary school and helps pupils organize their thoughts, and raise their critical thinking. It helps in combining various disciplines like, mathematics, arts, religion, language, poetry, history etc (Baker et al., 2012). When GIS is combined with other high technology, like GPS, it can increase student interest for activities which are not so beloved among the pupils.

The use of GIS technology pre supposes spatial understanding which, in turn, assumes spatial thinking. Spatial thinking is considered to be fundamental (National Research Council 2006) and the report "Learning to think spatially" states that this knowledge is applicable across the life span. GIS methods for teaching in primary school have not been searched enough yet maybe because science education focuses on old assumptions and on what children can't do rather than what they can do (Duschl et al. 2007). Geospatial technologies (GIS, GPS, remote sensing, virtual globes) as emerging technologies, are not considered to be so important in European education (Milson et al., 2012, Gaudet and Annulis 2003).

On the contrary, spatial thinking is integrated in the national curriculum of USA. Although some believe (Gersmehl and Gersmehl, 2006) that spatial thinking has an increasing resonance by the legislators, this is not the case in Greece yet. Although, many authors state that the inclusion of GIS in the school curriculum promotes critical thinking and analytical skills (Kerski 2001, Milson and Alibrandi 2008, from Goldstein and Alibrandi, 2013), GIS and spatial thinking remains mainly a university subject in Greece. Geography education ends up in 2nd grade of the Greek secondary school (8th grade in K-12). No GIS courses exist in secondary education (neither lower nor higher) although it seems that the teachers would be interested in attending such courses. Taiwanese teachers state that they acquire their GIS knowledge mainly from workshops and secondary by courses (Wang and Chen, 2013). In Greece primary school teachers are more skeptical about GIS itself. No connection can be found neither between geography and other disciplines in the Greek curriculum nor between the two levels of education (primary and secondary) so, the interdisciplinarity of geography is only theoretical and not shown in practice.

This becomes more frustrating because today there are lot of free data available in the internet and much information and knowledge that characterize our networked world. Thus, teaching with GIS for analyzing patterns, relationships and trends is out of the question because teachers do not understand what GIS offers. In a survey conducted in 2011 in Thessaloniki, Greece, 86% of the primary school teachers didn't know what GIS is but they knew how to use Google Earth and recommended it as an educational tool in geography teaching (Katsinou and Konstanti 2011 unpublished thesis). In the contrary, people are aware of the use of GPS but only as a navigation tool installed on a car. They make no distinction between GIS and GPS and they think of GPS as an instrument which has a preloaded map of a given area. So, they think that GPS and maps go together on the same instrument and GIS has nothing to do with it.

Today anyone with access to a computer or a Global Positioning System (GPS) receiver can make maps and publish them on the Internet, instead of relying on private publishers to produce it for them (NRC, 1997) (from The National Academies 2006: 32). Geography educators need maps for educational purposes and these maps should be made by educators. The educators know the geography curriculum and they can decide what exactly they need from a map in order to teach properly.

In this study we focus on new technology as a mean to provoke the approximation of disciplines which are more or less connected to geography. These disciplines are (local) history, ICT, linguistics (poetry), mathematics, religion, arts (handicrafts, drama) and finally local tradition in terms of folk museum and local recipes cooking. We don't mean that the approximation of these disciplines needs new technology as a Trojan horse. In fact, what it happened was exactly the opposite. New technology, such as GIS software and GPS units, were used in combination to local history teaching in order to find out how easily the pupils can adopt the use of high technology when combined with school courses and matters of their interest.

## 2. METHOD

### 2.1 Aims

The study had six aims to achieve: 1) The pupils should learn about the history of their village. This was the main issue of the study. In fact the whole research was based on the interdisciplinarity of geography and history as it is mentioned in the text book of "Study of the Environment" of the 4th grade of primary school. In this case, local history was the cause, 2) familiarize with new technology and use of instruments. In this case new technology refers to the outcomes of the use of GIS software, GPS and ICT in general. The challenge was not only to let the pupils know what all these are needed for but how they work as well, which means that the pupils would learn how to use instruments like GPS.

This raised two more issues: 3) the students should be informed and aware of geographical concepts like parallels and meridians and coordinates, compasses, maps and every concept that may arise from the use and understanding of map reading, interpreting and constructing, 4) therefore, the pupils of different grades had to work together as a team regardless the age differences and the level of knowledge. The last two aims would come up, in fact, as a result of the previous ones because 5) the pupils would realize that there is no school discipline that can be separated from others, they all can be taught at the same time and 6) To determine whether 10 years old pupils can use geomedia (GPS – GIS), taking into account the reluctance, so far, of the Greek Ministry of Education to include geomedia and high digital technology in the Greek geography national curriculum.

Moreover, we hoped that the results of the project would interest the policy makers and especially those making the Greek geography national curriculum. For the fulfillment of the project the Hellenic digital earth Centre of Excellence, the Department of Primary Education at the Aristotle University of Thessaloniki, Greece, and the Primary School of Agia Paraskevi, Kozani, Greece were involved and they addressed to the 4th, 5th and 6th grade pupils of the above mentioned primary school.
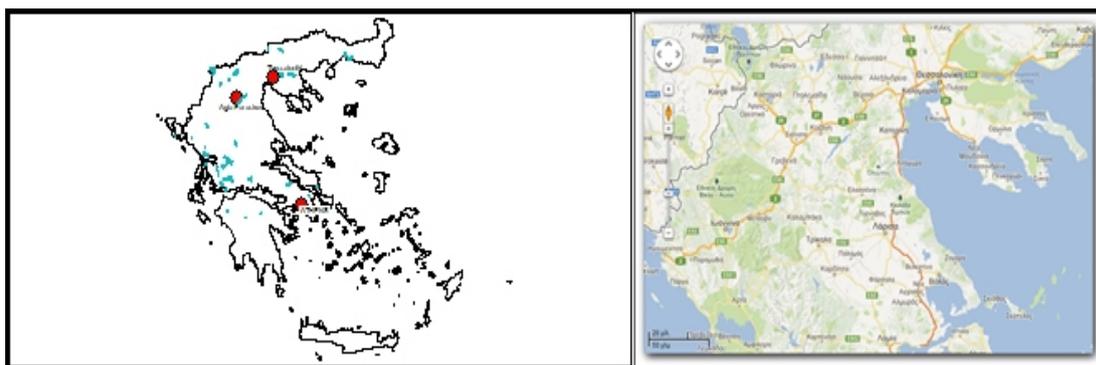
**Figure 1.** Location map of the study area.

## 2.2. Materials

The pupils of all three grades used several materials during the project. Some of the materials had a direct effect (Table 1) on some of the school disciplines while some others had an indirect effect (Table 2).

**Table 1.** Materials used in the project that had direct effect on school disciplines

| Direct effect | | | |
|---|---|---|---|
| **Materials** | **School discipline** | **Materials** | **School discipline** |
| Maps<br>Compasses<br>GPS | Geography<br>History<br>Mathematics | Microsoft Word,<br>Microsoft Power Point,<br>Internet Explorer,<br>ArcGIS, ArcGIS<br>Online | Computing |
| Glue<br>Brushes<br>Cardboards<br>Scissors<br>Paints<br>Newspapers<br>Pieces of textile | Arts | Photo Digital cameras | |

**Table 2.** The same materials had indirect effect also

| Indirect Effect |
|---|
| − Language (the pupils wrote short text about each place of local interest)<br>− Environmental Studies<br>− Religion (due to the study of the remnants of a very old Christian church – 5th century A.D. with very beautiful frescos)<br>− Literature (poetry) |

## 2. METHODOLOGY

The project was based primarily on the use of the maps and compasses and secondarily on the use o GPS. The motive for the children, in fact, was the use of the GPS units. When the pupils were asked if they knew about the use of GPS some of them said that they had GPS units in their parent's car. They all knew that a GPS shows where you are but they didn't know how and why. In every case, their conception was found to be wrong because they thought that a GPS has always a base

map as a background and that the base map is a part of the GPS unit. The units we had and used by the pupils were very simple. They didn't have a base map and it was not possible to transfer points from the unit to a computer automatically. The unit could show only a dot on the screen and a path connecting successive points of visit. The choice of these units was deliberate to force the pupils use their map and compass. The main idea was to have the pupils get the coordinates from the GPS unit, find them on their map and put a dot on the map for each point. This is the reason we wanted to have very simple GPS units without a base map.

This method pre supposes that the pupils are aware of the parallels, meridians and the coordinates and how we use them to find the absolute location of a place. For that reason the teachers of the school had to lecture on these issues in the classroom. They started from the parallels, then the meridians and finally the coordinates. These are to be taught at 6th grade but this year (2012-13) the Ministry of Education, Greece, had decided that these issues will not be part of the geography national curriculum. Instead, they will be taught in the lower secondary schools as part of the lower secondary school curriculum. Beside this problem, we had to discuss with the pupils how to use a compass and how to orient their maps in practice. This is something they had never done before so, it was their first time to learn how to orient a map by using a compass. Also, it was their first time they had to use a compass. We left the classroom and went in the school yard (there was a very big school yard with a very nice view of the surrounding mountains). There the pupils realized the necessity of a compass and how we find ourselves on a map when we are in the field. Until then, we hadn't give them the GPS units.

As long as the pupils were familiarized with their map and compass (each student had his/her own map and compass) and they were able to work with them, we decided that it was about time to explain how a GPS unit works. There was one GPS unit for every two pupils.

They learned what a GPS system is, how it works and why we need the satellites and maps. Now, they knew about the coordinates, the meridians and the parallels and they had to combine this knowledge. They learned about the satellites and their orbit and saw how the GPS unit communicates with the satellites. So, they were lectured on the GPS unit, how a GPS unit works, and why we need it.



**Picture 1**. Map reading and use of GPS units

Finally, they worked on their map. Reading and interpolating the map were the most important issues to learn in order to locate where they were on the map. They verified their placement estimation on the map with the coordinates given by the GPS units.

### 3.1. The procedure

Before we get started with the pupils, the participating teachers and us went all around the village to collect the points of interest which were connected to the local history. These were mainly: a) the primary school building, b) a well which, in the past years, served as the place for washing clothes, tapestry, etc. c) the old Christian church of 5th century with very well reserved frescos and d) the main square of the village with the plane tree. In between those points we collected a few more in road junctions, for example, just to make sure that the children will follow the same route with us. All the procedure is shown in figure 2.
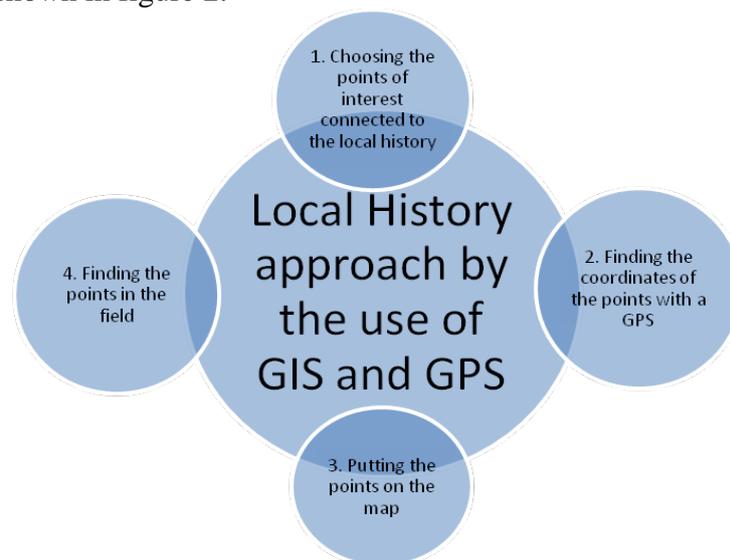
**Figure 2**. The procedure.

The map used was based on ArcGIS basemaps (fig. 3) and the most important thing was the coordinates and its scale of 1:20000. The pupils had never before a map of their village with so detailed coordinates. The project was going to be based on these coordinates. Also, the roads were visible on the map, except one-two new roads which were constructed very recently.

**Figure 3.** The map used by the pupils to locate the new points of interest

One lecture was given to the pupils and teachers about GIS. The lecture was on "what a GIS is, why do we need it, how it works), etc. The pupils were divided into two groups. The first one was planned to go to the points of interest and locate them on the map in two different ways: a) match the surrounding characteristics with those depicted on their map and b) by the use of GPS. In the first way they were supposed to use their compass, orient their map (which was made especially for this occasion with ArcGIS) and then started reading and interpolating the map. They had to look carefully around for places that they could find on the map and then proceed with the interpolation. When they were ready and found themselves on the map, they had to explain how they came to that conclusion. When all the pupils put themselves on the map more or less correctly, they were allowed to use the GPS units to verify their result. This way the pupils put 5 points on their map.

This group was consisted of the pupils of 5th and 6th grade. The second group of pupils, of the 4th grade, used these maps to find the places. They didn't know which places were chosen by the first group so they had to look for them. In their case, the main task was the use of the map and compass and secondarily the use of the GPS unit.

In the first place they learned how to use a compass and how to orient the map. They were told to put themselves on the map without the use of the GPS unit. This was important at this point of the project because it reflected the work done so far by their teacher and according to the Greek geography national curriculum. It was a first test of what they have learned in the classroom. Next, they were told to use the GPS

unit to verify their opinion and to locate themselves on the map in an absolute way. As it was explained earlier, the teacher had taught about the meridians, parallels and coordinates. The pupils did some exercises on a map in the classroom and now they had to apply this knowledge on a new, detailed map of their own village. Moreover, they had to locate the coordinates of the point they were standing on. The important thing was that it was THEIR point, a point that meant something to them and not just another point on an indifferent map. That was a real motive to them. Each point had its own history and now they were there to talk about it. They had to use the GPS unit which, until now, it was a unit only for the adults and as long as they had the coordinates, they could locate that point on the map. All the pupils knew that the coordinates correspond to a meridian and to a parallel. All the pupils located the points very easily and they felt very proud because they did it very quickly without mistakes. They knew HOW to use a GPS. In their eyes, that was the most important gift from that activity. From that point and onward they had no difficulties. They went to every point on their map and did the same procedure. They wanted to do it for two reasons: a) to show that they knew how to locate themselves on a map and b) they wanted to use the GPS unit to verify their decision.

## 3.2 ArcGIS - AGOL

By the end of the school day, we had an updated map of the village. The map had five new points and we wanted to show this to the community. We decided that we had to put all the points on a new map in a way that each point would have its own symbol, a symbol that would speak of itself. In order to do so, we decided to use ArcGIS to make, along with the pupils, the new map. And also, to make the new map available to everyone who might be interested in visiting the places of special interest of the village or learning about the history of each of these places. The most contemporary way to do this was to show the points on a map which then will be published on ArcGIS on line (AGOL).

The first thing we did was to lecture on what a GIS is, how it works and why we need it. Using very simple language, many examples and ArcGIS the pupils of 4th, 5th and 6th grade realized how we make maps today and how easy it is to put new things on a map or make changes on an existing map. At the end, we let the pupils choose, among the large list of symbols, the most appropriate symbol for each of the points on their map and put it on the map. The pupils tried many symbols and finally decided to use those shown in Fig. 4. During the process they changed their mind many times and put many different symbols as well as different colors (the girls wanted a pink hue and the boys a more masculine style). Finally they agreed on the map shown in Fig. 4.
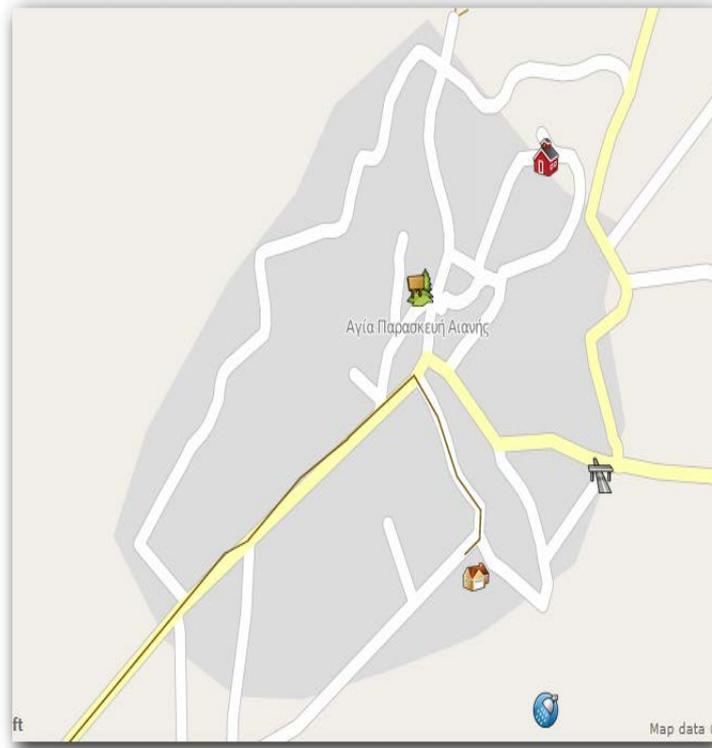
**Figure 4.** The map with the five new points and their symbols.

This map was uploaded onto the AGOL and the Local History Map of Agia Paraskevi village was ready with hyperlinks on each point (Fig. 5).
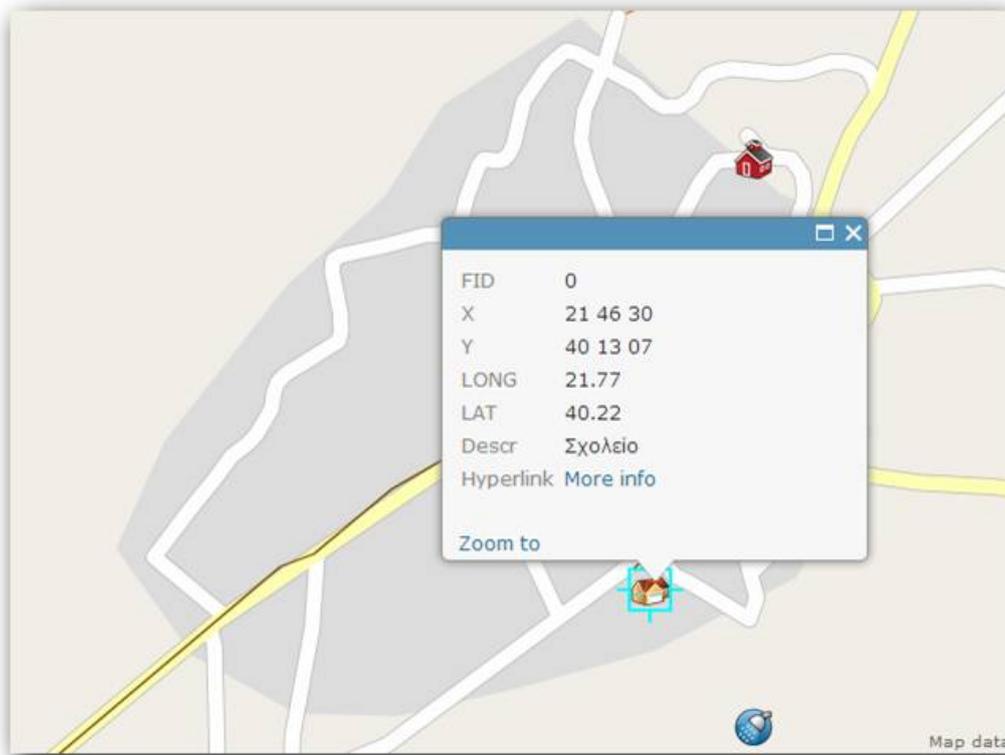


**Figure 5**. The map as was uploaded onto AGOL with explanatory links

The links guided to a small text and a photo showing the place of the point and describing in a few lines the history of the place. Under the text the pupils put their first name (Fig. 6).



Δημοτικό σχολείο

Το σχολείο του χωριού μας ήταν χτισμένο στην μέση του χωριού με δυο αίθουσες και μια μεγάλη αυλή. Μετά όμως από το σεισμό το σχολείο χτίστηκε στη περιοχή του Αγίου Αθανασίου έξω από το χωριό. Είναι ένα μεγάλο και καινούριο κτίριο το οποίο χτίστηκε το 1995. Έχει πάρα πολλές αίθουσες, μια βιβλιοθήκη ένα γυμναστήριο και τα γραφεία. Επίσης μέσα στο κτήριο βρίσκεται και το νηπιαγωγείο. Στην αυλή του υπάρχουν δύο μπασκέτες και γήπεδο του βόλεϊ.

Θεολογία, Αρετή, Δ' Δημοτικού, 2012-2013

**Figure 6.** Point number one - Photo of the Primary school and the explanatory text about its history.

The above photo was taken by the pupils and the text was typed in with Microsoft Word. They are both uploaded onto the school's web page.

### 3.3. Interdisciplinarity

We discussed, so far, how the pupils used the GPS units to locate the points of interest on a map made by ArcGIS and then how this map was uploaded onto AGOL. The most important aim of this project was to help the pupils learn about the local history of their village. The interdisciplinarity of geography is well presented in the literature, especially the connection between geography and history (Lambrinos, 2009 cum lit.). The challenge is to make it work with the pupils in a way that they will follow it with pleasure. In our case this was done with the help of the GPS units, the compasses and maps in the field. While walking and locating the points we visited places where the teachers presented the local history and what each place meant for the locals in the past years. All these were connected to the exhibits of the local folk museum and to the interviews with the older people of the village (Fig. 7).

**Figure 7.** A diagram of the local history "route" followed during the project

During the visits and the discussions, the pupils kept notes and used them when they were back home to search through the Internet for more details. They also took some pictures of the places because they wanted to upload them onto the Internet along with a small explanatory text for each point (Fig. 6).

In the folk museum the pupils saw some tools which were in use more than 50 years ago. These tools were mainly for growing fields, sewing machines and for cooking. Especially the latter led to the cooking of traditional recipes which, some of them, were no longer known, although proved very tasty during the food-testing at the last day of the project.

At the end, the project approached the following disciplines in various ways (besides geography and history): a) language (especially poetry), b) mathematics, c) environmental studies, d) religion, e) theatrical education, f) computer technology, g) arts and h) literature.

## 4. CONCLUSION

The results of the project are linked to geography, history, ICT and arts. In some cases that results come directly during the procedure and some other come indirectly. Both are very important.

Starting from geography, one major result is the ease with which the pupils learnt about the coordinates. It took them one lecture to learn about the parallels, the meridians and the coordinates. At the end of the lecture the pupils had a small practice in calculating the coordinates of some points on a map because the teachers knew that the pupils had to know how to make the calculations in order to proceed with the project. That could be "an answer" to the Greek Ministry of Education regarding what the pupils of 4th, 5th and 6th grade can do/learn (age of 10 – 12). Moreover, as we knew that the pupils knew nothing about parallels, meridians, coordinates, compasses, GIS and GPS units it was easy to form a questionnaire containing questions on all these matters. There was no need to give it before the beginning of the project as most of the questions would get no answers.

The questionnaire was given to the pupils after the end of the project. It was consisted of 2 open and 10 closed questions and they were all about the concepts they worked with during the project. The results were very successful. The correct answers

ranged from 84% up to 100% and showed that the pupils had understood very well everything they did. That is attributed to the fieldwork which was very well supported by the lectures.

More than that, the pupils learnt how to use the compass in combination to the map, how to locate themselves in the field, how to put themselves on the map, which pre supposes that they were able to orient the map (correct use of the compass) and they could read and interpret the map.

The pupils of 4th grade (10 years old) were able to do all the above mentioned procedures and when they were asked "why do you think that this is the point we are looking for" they were able to identify the surrounding characteristics and recognize them on the map. That was very important because it was their first time that they did in fact the saying "you will not get lost if you have a map and a compass". After this, they used the GPS units to get the coordinates and verify their location on the map. Again, they did it very easily, after the first time when it took them about 20 minutes to realize what a GPS is and how it works. From that time and then, they used the GPS units very easily in every point they wanted to get the coordinates.

The local history was the second most important result of the project. The pupils visited places they knew as locations in their village but they had never realized before how important they were for the villagers in the past years. They didn't know their actual use because most of them were almost abandoned today or their usage is not the same as in the past. For example, the well was very important as it was the only source of drinkable water and the only place the villagers could wash big covers, like carpets, of their houses. This well was also important because they used it for watering their livestock which is something they do today also. In other cases the pupils learnt about the everyday life of the villagers 70-80 years ago. This is how they "discovered" old recipes which they used old cooking instruments which do not exist in today's kitchen. And they cooked (with the help of their mother) these recipes for the last day of the project.

So, there were places with a history which the pupils would like to highlight. And they felt the need to show to the rest of the people, or to whoever would like to visit their village, what these places meant to them.

The best way to express yourself is to use a map, onto which you can point places to visit for special reasons. And it would be perfect if you can show to others where these places are located, how you can get there and what you are going to see. Fortunately, today is easy to show all these on a map. When the pupils were asked if they would like to make a new map of their village with all these places, they all agreed on. But they didn't know how to do this, although they said "can we put it on the internet?". So, they were delighted to hear that there is a special way to do this, and more, if we use a GIS software to build our new map.

That was their last lecture concerning the project and their first chance to listen to what a GIS is and how it works. After the end of the lecture they were told that they could enrich their map if they use beautiful colored symbols. This is what they did. In a few minutes they were able to look for the best symbol for each of the points they had collected in the field. Before that, we put on the map the points and they had to change the symbol of each point (an asterisk) with the symbol of their choice, with the agreement that the new symbol would be relevant to the place. Again, the pupils of 5th and 6th grade did it very easily. They searched all the symbols that ArcGIS has and put each one in the right place. They also used different colors for the symbols. The final step would be the collection of information for each of the points-places of interest. The pupils were divided into groups and searched the internet for

information. Some others took photos of the places and finally typed in short explanatory text for each of the points-places, using Microsoft Word. All these (photos and text) were sent via email to the project coordinator (they used the email address of their teacher) asking to put them onto the map.

The result of this procedure was a wide use of ICT. They used a GIS software, a word processor, Internet, an email software and finally a software for presenting the results of their work to other pupils of their school. The new map was uploaded in AGOL(http://www.arcgis.com/home/webmap/viewer.html?webmap=24d0dbca62ad4 13bb1a3a2659c91901e ) and the photos and texts were linked to the map points (fig 5 and 6). The presentation was based on a Microsoft Power Point file.

Last but not least was the occupation with arts. The art activities involved mainly the pupils of the 4th grade although the pupils of 5th and 6th grade were very active also. The pupils of 4th, 5th and 6th grades constructed a map (Picture 2) of their village which proved to be quite precise taking into account that those who saw the map found their houses very easily and found also the houses of their friends.



**Picture 2.** The village map constructed by the pupils

The map was made on a long piece of paper in order to serve as a wall map of their village. The collaboration not only within the grades but also among the grades was very interesting because, after almost 4 months of collaborative work, there was no school violence (bullying).

The pupils of 4th grade did also a globe (Pic. 3) with recycled paper because they wanted to link the parallels and the meridians with the world. Moreover, they wrote two short plays, dramatizing the transition from the past way of teaching about the environment, which was based on a text book, and the new, contemporary teaching, which involves the new digital technology. The second play was about geography and its importance.

**Picture 3.** The globe was made by the pupils of 4<sup>th</sup> grade with recycled paper

The final results of the project can be summarized as follows:
- Pupils of 10 years old can use geomedia
- Pupils of different age and grade can work together in a common task as far as each group of pupils understand its part
- Develop their creativity through photography, construction, theatrical events, and want to share their experiences with others
- The cooperation of different ages helps to reduce school violence (bullying) and to develop positive feelings among the pupils

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