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Assessing History with Mathematical Tools: The Use of GI Systems in Social Sciences

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Abstract

The complexity of everyday structures in today's world asks for adaptation also in teaching, no matter if in high-schools or at universities. Our educational institutions are especially challenged when it comes to the teaching of interdisciplinary aspects. Digital media have the key role within this topic and teachers must not complain about the ubiquity of content as too distracting. They have to make use of it! This paper shows an example of best-practice which was conducted within a European project amongst five participating schools in five different countries. It shows how mathematical tools, in this case a System for Geoinformation (GI), can be used to utilize historical information and create a historical learning ground at the same time.

Keywords

Mathematics, Computation, GIS, Digital Maps, Geography, History

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1. Fundamental Changes in Cartography

The fast developments in mathematics and computation and the new gateways to digital maps which are connected with each other (or have even been constructed by it) ask for new approaches in student training at our schools also beyond the school subject Mathematics (cf. Hemmer 2012). Several main requirements can be deducted from that: The manifold options for an individual to orientate oneself nowadays have to be evaluated and need to be assessed with regards to the resulting spatial distortions. On the one hand navigation and orientation appear to be much easier today with optimized and customized navigational tools at everyone's fingertips. But on the other hand these blessings by and large weaken one's ability to orientate oneself in space when moving around (see Barnikel et al. 2014). The importance of mental rotation for example has only been understood in parts, so far, we apparently believe in a kind of map in our heads that is north-oriented (Frankenstein et al. 2012), a finding, which challenges the custom of rotating maps in digital devices.

Now how can spatial competence be taught or improved, especially because spatial navigation is seen as a particularly complex multisensory process, in which ability users are found to differ widely (Wolbers & Hegarty 2010)? The differences between traditional (paper) maps and the new digital maps are obvious, in several respects. But what can a teacher do to not only embrace the creative options and the fabulous functions of the new media but to also keep the undoubted advantages of classical maps? How can a teacher in fact serve both worlds? Schools can easily try to change the situation, simply by making students create their own maps, digitally. And this is exactly where the online GIS comes in.

2. The Use of Geomedia in Schools

GI Systems (GIS) work on a numerical basis. The data are collected in data bases and computed to visualize certain

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findings. The structure of the system is a group of layers, each containing differing information, and all of them calibrated to an underlying map. As a result, the data can be organized in a visual way and located at their respective locations at the same time. Since this concept is widely used and published nowadays but not implemented in most high school curricula all around the globe, the students first need to be made acquainted with the tool.

When manipulating a map students can learn a lot about the way maps function (cf. e.g. also Garfield 2013). To reach this goal the teacher can use a common online GIS (arcGIS online, Google My Maps etc.) accessible via internet. Already in lower secondary school students can create their own first maps in a kind of construction kit (on this topic see Hoehnle et al. 2011, about simple digital maps e.g. Barnikel et al. 2013, more complex digital maps with the professional GIS arcGIS 9.3.1 for example in Ploetz et al. 2014).

The earlier students approach the topic of creating maps, the better. Students of the lower secondary level for example can first collect locations in the vicinity of their school where they "feel good". That can be a park or a playground, a bakery or a football field etc. To find out these places they may want to spend a lesson outside the classroom. The locations of the places of well-being are then marked in an analogue map (a copy of a street map etc.). They can also of course map other aspects in the neighbourhood of the school, like the height of buildings, the age of the houses or the different forms of usage of these buildings. The school subject, where these mapping exercises are conducted, does not necessarily have to be Geography. Maps like this can also be created in Languages, Religious Education, Mathematics etc. Statistics can be made for Mathematics etc., this application is full of opportunities! Multidisciplinary teaching always makes sense when doing exercises with an online GIS.

By performing these first little exercises the students combine the advantages of analogue maps (size, good overview with lots of details at the same time, accessibility, and so on) with the attractiveness of digital maps. The results of their mapping activities in the computer lab look professional, they resemble map aesthetics the students know from Google Earth, the maps on their smartphones etc. On top of that, these maps can easily be shared with other people, accessed through computers of all sorts (mobile phones, tablets, PCs etc.), a genuine plus in today's highly connected world.

Because students nowadays in general are familiar with geoinformation, e.g. google maps etc! Our work with a professional GIS was meant to make active users out of passive ones. Even though students are used to work with tabulation programmes and text editing, working with the complex structures of the professional version of the tool ArcGIS 9.3.1 took their knowledge about software to a new level. Due to the fact that some of the students are planning to take creative jobs after school and that others want to try technical careers, many of them within the MINT subjects, a fruitful mixture within the group was achieved. So in due course more exercises were executed, this time with the professional tool ArcGIS 9.3.1. All in all the time to introduce the software and get familiar with it did not exceed two months. Some of the students rapidly became (much) more proficient with the software as their teachers and developed into GIS-experts. These results were eventually published in 2014 by Ploetz, Pinzek and Barnikel.

These experiences at our school motivated us to also implement GI-Learning to a European level within a Comenius-project together with four international partner schools. This Comenius-school-partnership (meanwhile re-named Erasmus+) lasted for two years and connected five schools from Germany, Belgium, Finland, Lithuania and Poland. The main goal was to make the students analyse their neighbourhoods under certain aspects and to then compare their findings with the students from the other participating schools. One of the early projects within the cartography part was the visualization of local living conditions with regards to housing infrastructure. The idea was to get a sort of first impression of the partners' neighbourhood via maps without actually seeing pictures from the area. To achieve this, three different aspects were included: The height of the buildings in the vicinity of the school, the age of the buildings and the use (private, business, public etc.). The students had to walk around the neighbourhood and collect the necessary information. Then they first coloured analogue maps according to their findings. A group of specialists (students who wanted to travel with the Comenius group to the partner schools in the participating countries) then collected the pieces of information and visualized them (polygons) in a simple online GI (arcGIS Online; Fig. 1) (Ploetz and Barnikel 2015)

During the different project meetings students from the five countries also worked together in groups to fulfill different tasks like the ones mentioned above. One task was for example to make the students find places where their neighbourhood was occupied by elements of youth culture. One aspect in this context was the search for graffitis. The geoinformation part of the workshop was then to map these graffitis and to attach commentaries. These activities, the places of well-being, the mapping of the graffitis, the charting of houses under certain aspects (and so on) can count towards a first theoretical understanding of the concept of digital maps. The students learn to see their environment

as layers, like the layers that make up a classical GIS. The environmental data is stored in these layers that they start to create by themselves. The combination of working "in the field" (three dimensions) and then mapping the findings (two dimensions) counts towards the improvement of spatial competence.

Spending time outside the classroom to map the locations, the connection of these locations with content and the then performed mapping in the computer lab leads to a deeper understanding of space and content within just a few lessons. But there are also examples how to reach these results in subjects other than Geography.

Figure 1. Excerpt from a map about the Munich city quarter Neuhausen; simple students' mapping with arcGIS online on the basis of an openstreetmap; green: Built after 2000, red: built between 1945 and 2000, blue: built before 1945.

3. Digital Maps in the School Subject History

Just to show an example how working with geoinformation can also enhance history lessons (for a project even with students at Primary level see Lambrinos & Asiklari 2014): During the aforementioned Comenius project students were asked where their grandparents had come from (this was done anonymously). Their findings were inserted into a digital map as point shape symbols. Since each school had been assigned a different colour, a fast overview on migration within Europe could be found (Fig. 2). The map was accessible in the cloud, so each school was able to add new content easily and at the same time.

It is obvious, but not surprising, that, at first sight, the Belgian and Polish grandparents were much more "philopatric" than their Finnish or German counterparts. Of course this needs to be addressed by the teacher and discussed in class. The underlying reason was of course the Second World War and the events connected with it. The interdisciplinary approach gave the students an incentive to talk, when together with their partners from the other participating schools, even in English, since this was the language of our communication.

The students discussed the history of migration within Europe for the second half of the twentieth century, in some cases events even dating back to the time before World War II (grandparents!) and the push- and pull-aspects associated with it. Whereas one community show very limited migration (the school in Belgium), another school had grandparents from all over the country (Finland) and the German school ancestors from all over Europe. In a next step the students were invited to add short stories or characterizations connected with the places where their grandparents had been born. The fates and the stories of the grandparents were, as a consequence, localized and mapped digitally, as a digital from of oral history (Fig. 3).

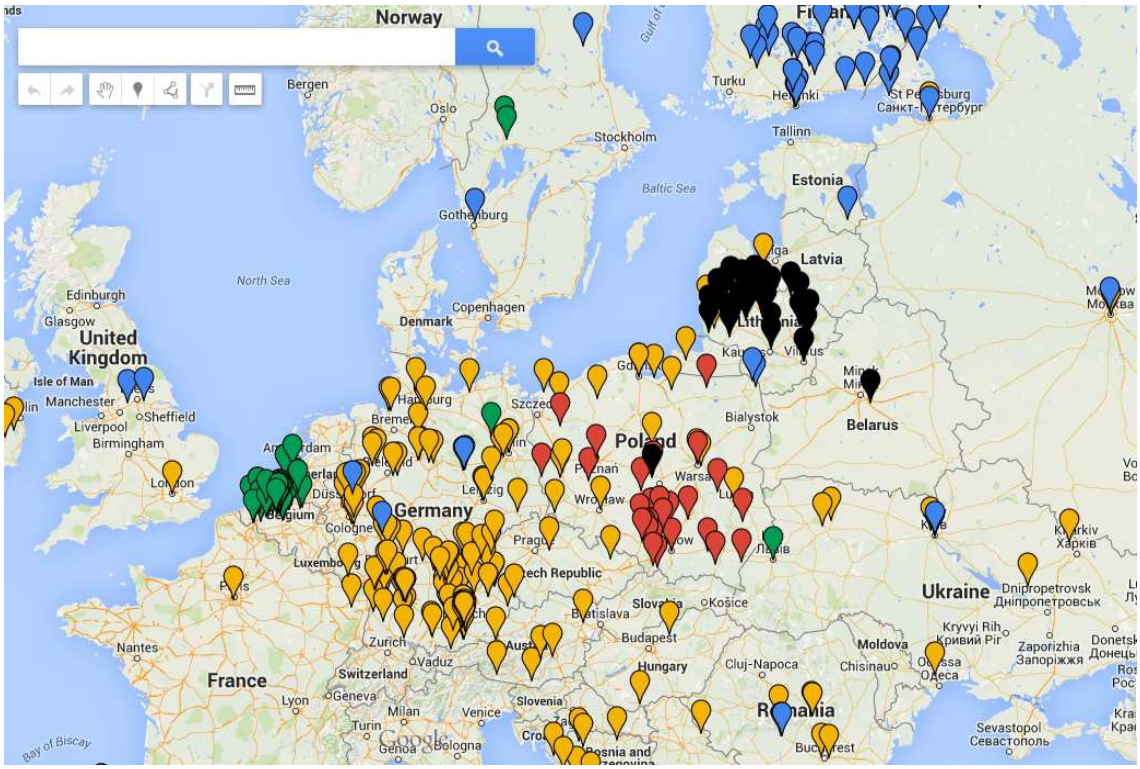

Figure 2. Where do your parents come from Blue: Finnish answers, green: Belgian answers, red: Polish answers, yellow: German answers, black: Lithuanian answers; Google My Maps.

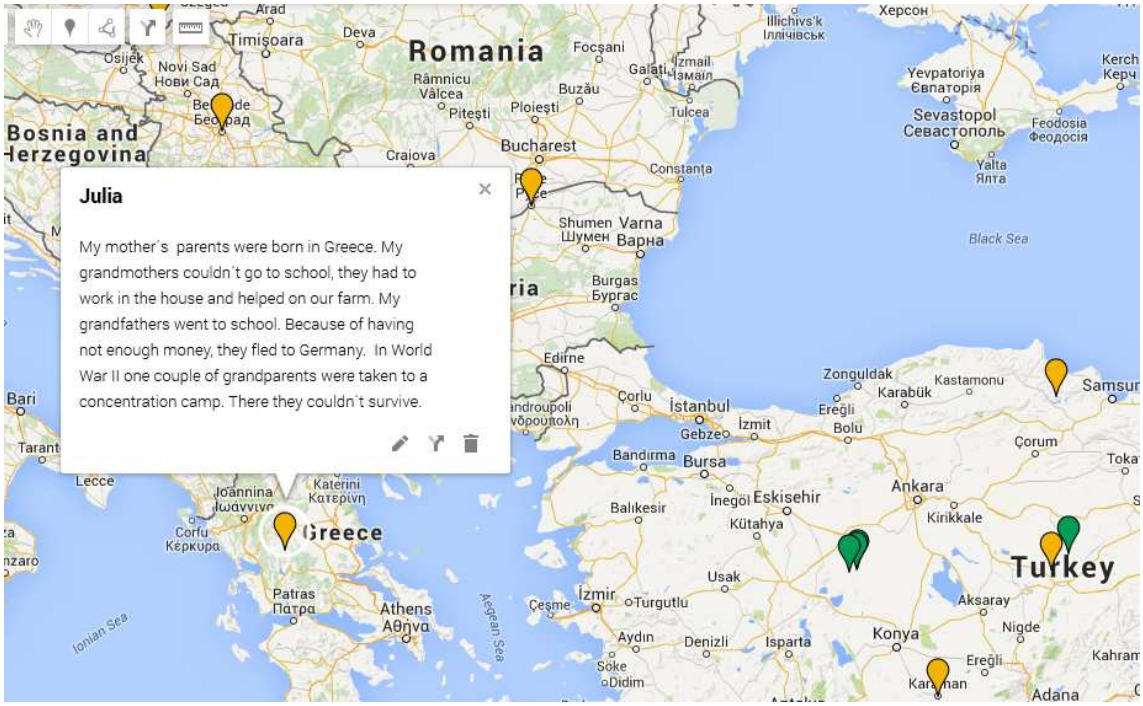

Figure 3. Stories from and about grandparents. Part of the Comenius project „Life in Our Neighbourhood – Life in Our City“ at the municipal Adolf-Weber-Gymnasium in Munich; Google My Maps.

4. Outlook

Within the frame of our co-operation new insight views on living conditions, culture and school systems came into existence. Multidisciplinary and activity-oriented project teaching offered the students the opportunity to experience and shape their own present and future in a Europe which is

growing together incessantly. The professional maps with an online GIS as results of the students' project work were beyond expectations. Just a few years ago this achievement would have been impossible, for teachers and students alike. The neighbourhood around the school was, analogue to the functions in GI systems, more and more seen as a combination of thematic layers. Dealing with "space" resulted in clearer spatial structures and thus in spatial competence.

The digital revolution has an attractive side effect for schools. Digital maps are widely available, not only for geographers but also for teachers in all other kinds of subjects. To manipulate and construct these maps is not only a very creative process, it is also very welcome due to its learning-by-doing approach. The connection of map-making and subjects of all sorts is easily to be reached. Working with an online GIS is much easier than working with a more demanding professional tool. Every teacher who can use a computer is able to work with online maps. The main aspect in this context is the creative autonomy of a teacher within his or her own classroom. Topics to work with exist in abundance. The positive results of working with an online GIS are manifold: improvement of orientational understanding, improvement of spatial competence, competence to work with a computer, understanding of subject matters etc. One just has to do it!

And, secondly, the work with easy geomedia tools is a fantastic way to quickly build confidence and a sense of cooperation amongst the students. It also teaches them how to perceive given maps and how to manipulate and create maps themselves. Quite a few positive aspects may be seen in this context. The students become more proficient in spatial competence in general, by spatially analyzing their environment and then by representing it via digital mapping.

They also learn how to organize and "shape" information by collecting information and by selecting relevant (or subjectively chosen) details. In that respect they experience space that surrounds them on a new level and they realize that this space consists of different layers, like in a GI. This hands-on aspect, valuable in itself, is just the icing on the cake. Future tasks in that respect, no matter if at university level or in a job, will hugely profit from such proficiency.

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