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THE ACQUISITION OF SPATIAL COMPETENCE – FAST AND EASY MULTIDISCIPLINARY LEARNING WITH AN ONLINE GIS

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Abstract

The acquisition of spatial competence can be considered one of the major tasks of the subject Geography at our secondary schools. In this context teachers are sincerely asked to not only complain about the ubiquity of modern digital media (e.g. when students receive messages in their classrooms during teaching…) but to make use of it! The wide scientific field of maps and mapping competence offers fantastic opportunities to easily create and manipulate digital maps and, by doing that, helps the students reach a deeper understanding of how to illustrate space and content in an attractive way and how to navigate uncharted waters. This paper shows some small and easy best-practice examples of fast and simple multidisciplinary approaches with online GI services from a German high school to be used at secondary schools all over Europe.

Keywords*: geography, geography education, geomedia, GIS, spatial competence*

1. FUNDAMENTAL CHANGES IN CARTOGRAPHY

The explosive success of satellite and computer technology in the past few decades has revolutionized the precision when determining one's own position (cf. Bray 2014). While in the 20th century expensive navigational systems still needed to be tested at length (terrestrial navigation via radio waves or inertial navigation), nowadays the user of digital services has turned from being a simple data receiver into someone that transmits his or her own position at the same time. Smartphones send real-time signals about movements and locations and the telecom providers connect them with each other to form gigantic spatial data networks. The ubiquity of knowledge by means of internet access for almost every citizen in the western world (and in the meantime also in emerging economies) is flanked by a thorough knowledge about localization and navigation (cf. e.g. Butler 2006). As a result, the immediate access to knowledge about space and content can also be seen as the fundamental change within the field of cartography, which is of course a big challenge for our schools (cf. Heiken & Peyke 2007 or Donert 2009, for a general overview also see Gryl 2013). It is especially this field where future generations need tuition to gain spatial competence over time. Because meanwhile spatial education can be seen as the "fourth R", a linguistic quip recalling the

famous British postulation of the early 1800s, schools should teach three "Rs" before all other subjects: "*R*eading, W*r*iting, A*r*ithmetics" (see Goodchild 2006 on the topic).

The new gateways to knowledge 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 (cf. Hemmer 2012). Several main requirements can be deducted from that: The manifold options for an individual to orientate him- or herself nowadays have to be evaluated and need to be assessed with regards to the lamentable 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 without these little helpers (see e.g. Barnikel et al. 2014). This does not only have to do with the smaller screens of navigational devices as compared with analogue (paper) maps, it also has to do with the problem to mentally rotate maps when orientating in unknown spaces just with the help of digital maps.

In general, mobile maps (as digital maps in navigational systems or GPS devices) have become more and more widespread and tend to oust traditional analogue maps, even though the latter still are considered first choice when trying to get to know an area better (Willis, Hölscher & Wilbertz 2009). One crucial question in this context is the size of the display in contrary to the size of an analogue map and, in addition to that, the resolution of the displayed digital map when zooming in and out as opposed to the unchanging information in the analogue map. Another question is the north orientation. 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.

When students are asked to reflect on their usage of geomedia, digital and analogue, they say that by and large they are quite proficient with GPS devices for instance (handheld, navigational tool, smartphone etc.), but state that the necessary information was not always easily readable on the small and reflective screen and that all in all orientation with a classical map was easier and that the bits of information perceived were closer to reality than with the use of the GPS device. This is not surprising. Maps still offer a traditional, familiar and well practised access to real life environments as opposed to the difficulties map users have with the small display and the changing north arrow in a GPS device. The statements of the students are less clear in favour of the map, when the GPS devices are equipped with an underlying map or when they use tablet computers, where the display is generally bigger in size and of better quality than in classic GPS devices. In secondary education it is generally advisable to use maps for the exercises that are already available and not to use maps custom-made by educators (in contrast to the findings of Lambrinos and Asiklari for primary education, who, understandably enough, claim that in primary education "educators know the geography curriculum and […] can decide what exactly they need from a map in order to teach properly", Lambrinos & Asiklari 2014, 35). Dealing with the aspect of spatial organization in secondary education with educationally scaled down map material would on the other hand counteract the goal of spatial competence in the real world.

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? What makes things even more difficult is the tendency to badly mistreat the discipline of cartography at universities and high schools alike. The theoretical knowledge about maps and the way they are created is very limited nowadays. But the teachers can be helped. 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.

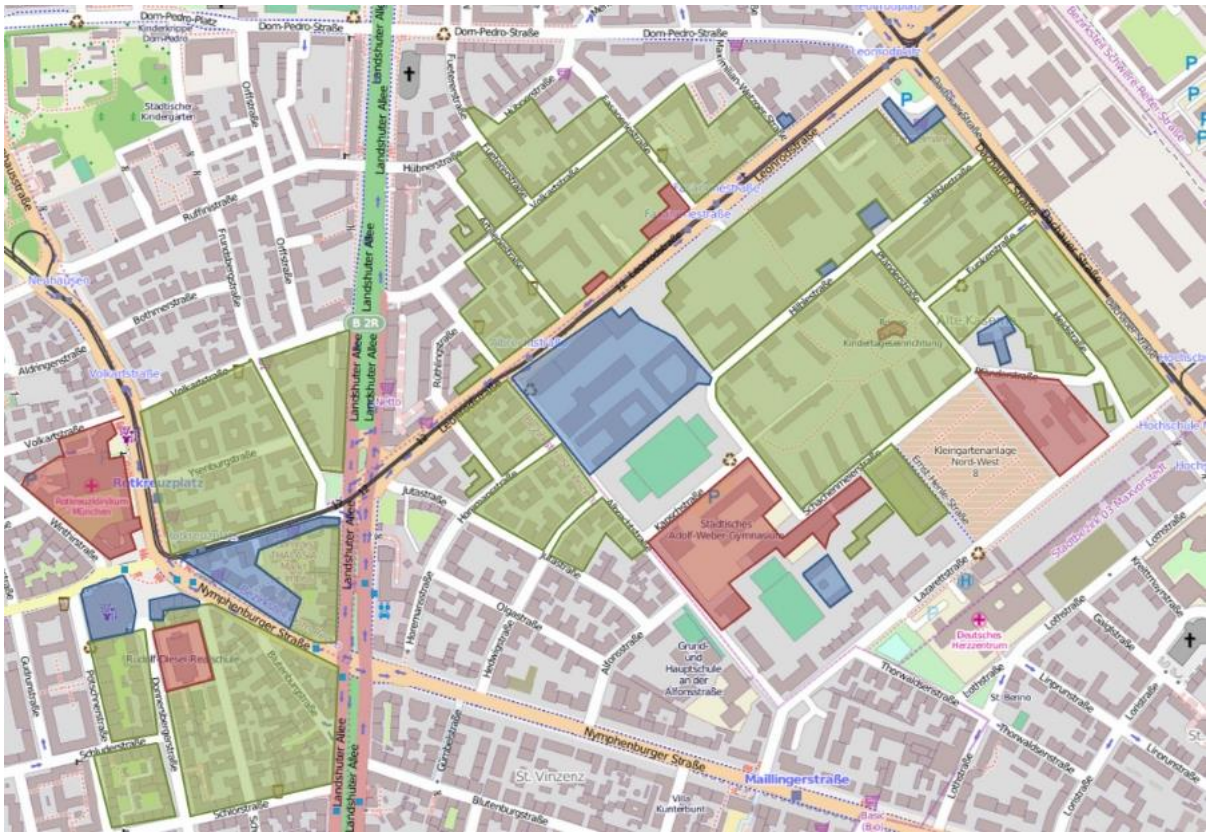

Figure 1. Excerpt from a map about the Munich city quarter Neuhausen; simple students' mapping with arcGIS online on the basis of an openstreetmap; green: private use, red: public buildings, blue: commercial use.

2. THE SIMPLE USE OF ONLINE GIS IN SCHOOLS

"The best way to express yourself is to use a map, onto which you can point places" (Lambrinos & Asiklari 2014, 44). 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 for instance 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 Höhnle 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 Plötz 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. (Fig. 1). 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.

Further examples for an easy start with an online GIS in schools can for instance be cooperations between the school subjects Art, Modern Languages, Mathematics and Geography as conducted at the municipal Adolf-Weber-Gymnasium in Munich along with other participating schools as part of a European Comenius-Project in the past two years (Plötz & Barnikel 2015). 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.

As a result of dealing with the living conditions in one's own urban district, the city/hometown and the cities of the partner schools, more openmindedness was fostered in all participating partners. The students got to know structures in their cities that were initially unknown to them. Furthermore, the students got to know more about their own living conditions and about the corresponding conditions abroad. This of course has a social component! By this the understanding of differing reactions on particular living conditions, for example when discussing differences in Europe, can grow and local differences in dealing with certain everyday situations may become more clear and understandable for participating students in the future. This also improves something we desperately need in the future, openness and increasing mobility within the European context!

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 was the search for graffitis. The geoinformation part of the workshop was then to map these graffitis and to attach commentaries (Fig. 2). These activities, the places of well-being, the mapping of the graffitis, and 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.

Playing with the three dimensions can also take place as an extracurricular activity outside the classroom. As performed with Comenius-partners during one of their visits in Munich, teachers can easily brighten up their everyday chores for the students with the well-known game of "geocaching". "Geocaching" is an international treasure hunting game. So called "caches", hidden boxes containing a logbook and sometimes little things to swap, have to be located with the help of given co-ordinates (which are routed and found with GPS receivers or analogue maps) and in some cases after solving some riddles (questions, quizzes) connected with the cache. This also adds to the perceiving of dimensions or "layers" and helps the students in acquiring spatial competence. Results from a geocaching-project in Munich with 336 students show that students gather experiences and acquire skills that they would not get in ordinary classroom situations (Ellbrunner et al. 2014). The connection between spatial skills and social skills can be seen as a great asset to geosciences education in general.

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.

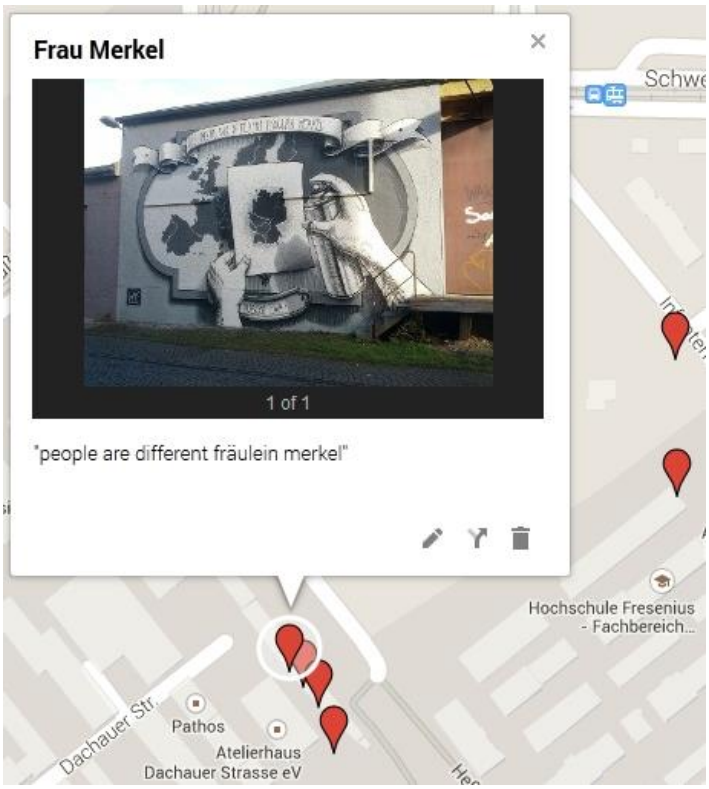

Figure 2. Excerpt from a map of Munich-Neuhausen with the localization of street art (Google My Maps).

3. DIGITAL MAPS IN THE SCHOOL SUBJECT HISTORY

Just to show an example how working with geoinformation can also enhance history lessons at Secondary schools (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. 3). 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 for the distribution of the birthplaces 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. 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. 4).

The discussion of historical aspects within a GI environment is generally probably one of the fastest growing fields in schools. Brauckmann (2015) discusses the connection of youth participation and a culture of remembrance by using geo-information. The advantages of allowing creativity during the building or manipulating of maps combined with the aim to illustrate historical data and content can be regarded a positive asset in a more conservative school subject like History, which so far is mainly based on text and static visual sources.

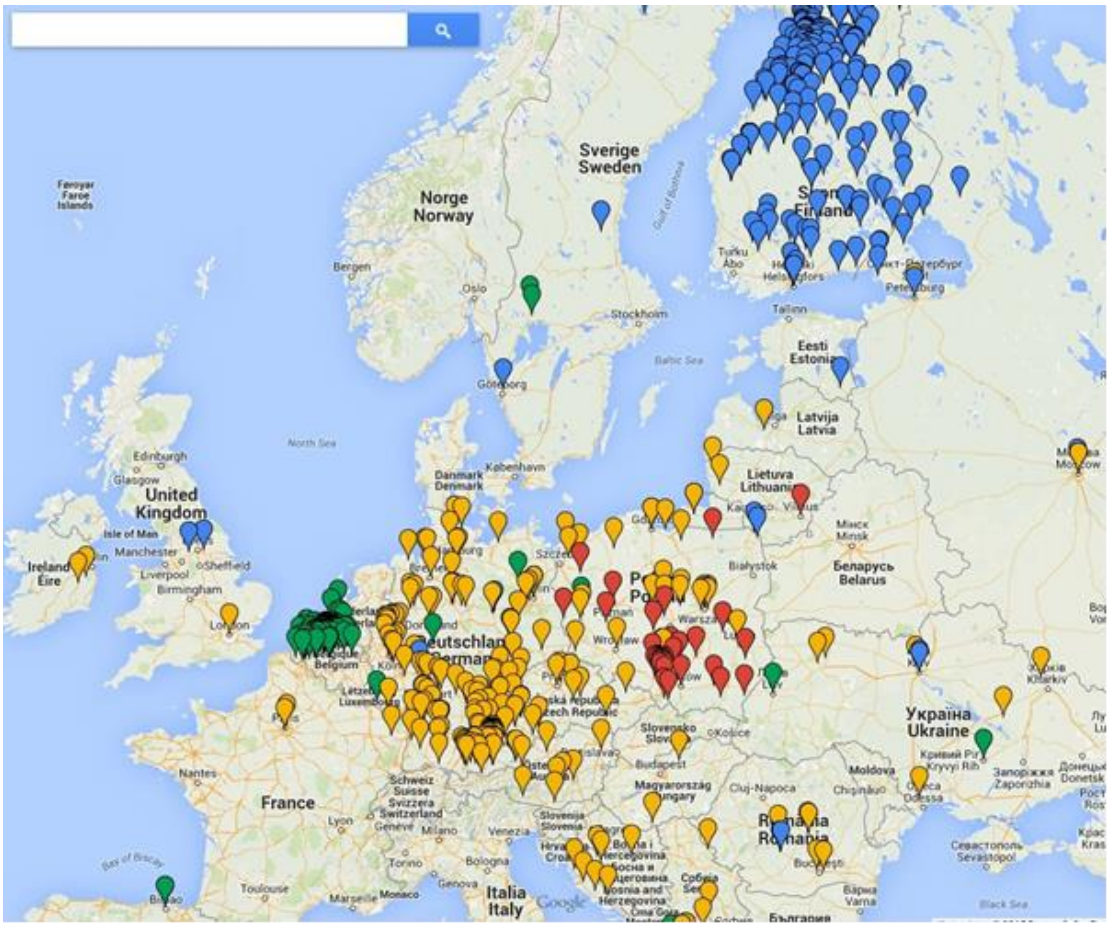

Figure 3. Where do your parents come from? Blue: Finnish answers, green: Belgian answers, red: Polish answers, yellow: German answers (the answers from Lithuania have not been added yet); Google My Maps.

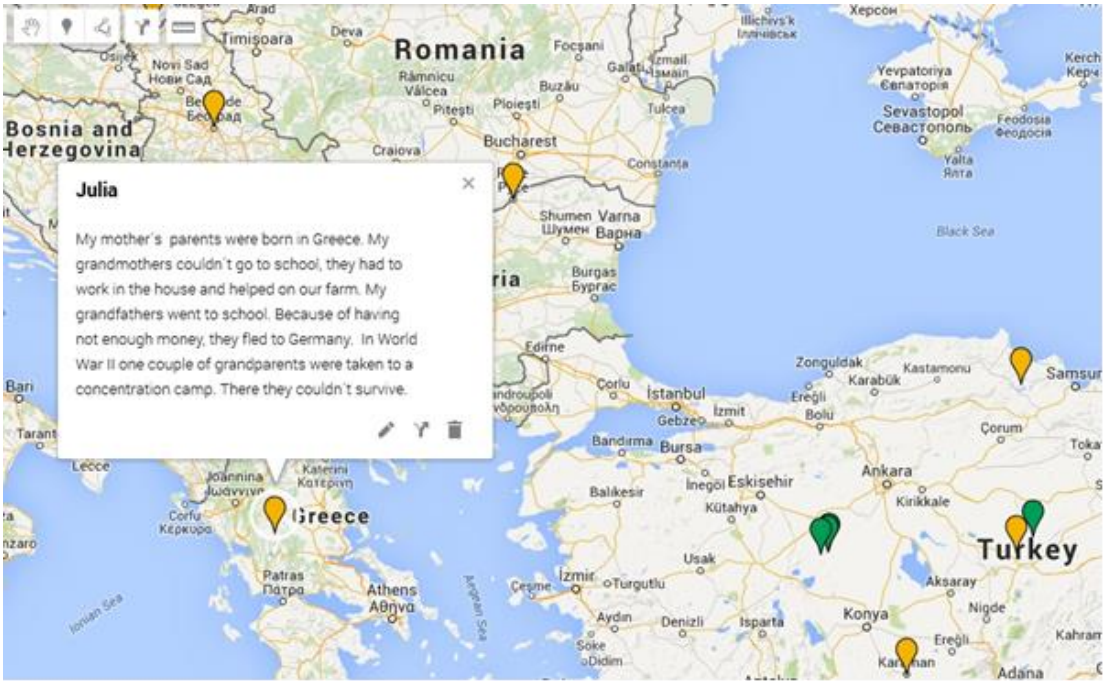

Figure 4. Stories from and about grandparents. Part of the Comenius project „Life in Our Neighbourhood – Life in Our City“ at the municipal Adolf-Weber-Gymnasium in Munich; Google My Maps.

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.

Mastering spatial orientation in addition could mean being prepared for unknown situations and by that adds flexibility to one's schedule. It makes the individual independent or at least less dependent on help or media. On the contrary, students mentioned that they would cherish the feeling of being able to help others find their way. Most students of course added that spatial orientation first of all means saving money (and thus also time) plus the benefit of being on time for dates/meetings etc.

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. One requirement connected with these findings is of course the improvement of usability of all sorts of GIS for schools (Düren & Bartoschek 2013). Without easy accessibility of online/web material the teachers cannot be expected to significantly contribute towards spatial competence in their students!

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., in short, choroinformatics in the best sense of the word (Koutsopoulos 2011). One just has to do it!

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