Chapter 2
Digital Geography Education in the Twenty-First Century: Needs and Opportunities

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Abstract The introduction of geospatial technologies is changing geography education very fast. Google Earth, web atlases and many location based services are available from the Internet and offer the opportunity to study almost every place in the world anytime anywhere. This opens up a great perspective for geography education in a way not known before. Nevertheless also in geography life is not just a bed of roses. The introduction of geospatial technologies is not always simple, due to technical problems and fast changing devices, a lack of experience in teaching with geospatial technologies and a huge amount of information that may prevent learners to see the wood for the trees. However, the advantages of using geospatial technologies in geography education far outweigh the problems if geographical thinking is involved. This contribution discusses briefly the needs and opportunities of digital geography education in the twenty-first century.

Keywords Geography education • Geospatial technologies • Geospatial thinking

2.1 Introduction

This chapter will start with a sketch of the core business of geography education. Then we will have a short look at the recent history of geospatial technologies in geography education to show where we come from and how fast the world of

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teaching with geospatial technologies is changing. Next we will discuss some opportunities and challenges we might face in geography education using geospatial technologies. In the following chapters these opportunities and challenges will be explored further.

2.2 Geography Education

One of our dreams as geography educators is that all over the world young people investigate and evaluate their living environments to discuss the challenges and future perspectives of these environments. And that they do this supported by their parents and their teachers, using modern means of communication and geospatial information technology. Sometimes we see signals that this dream comes true. School children from all over the world participate in environmental protection programs like DeforestACTION. This global learning project enables children to monitor Borneo's rainforest from drones and satellite images helping to protect it from illegal loggers (Fig. 2.1). Rapid illegal rainforest logging is escalating driven by an insatiable demand for palm oil from China, India and elsewhere. Palm oil is the world's most consumed vegetable oil. School children are becoming involved to help save endangered animals and their home, the rainforest. This hands-on approach of ecology and conservation-in-action empower young world citizens. DeforestACTION shows that together they can have a voice and play an active role in protecting the environment and our planet. Geography education will help students to raise relevant questions as where is deforestation taking place, at what scale and speed (where?), how does it happen and who is doing it (what?), why does it happen (why?), who is benefitting and at the expense of whom and what (consequences?), what are the alternatives (policy?), and how does this all relate to myself and our society (awareness and commitment?). Geography education is about meaningful learning starting from geographic questions. It is the fascinating story of people that live on planet earth at different spots in different ways in conditions that change continuously. Morgan (2013: 275) analysing a text of Mackinder states that

> To think geographically is to have a trained capacity to construct a mental map to see patterns, to recognise relationships, to see movement, to take that map and 'clothe it in meaning.

The digital revolution offers more and more fascinating possibilities to discover planet earth. Computer technology, the Internet and Global Positioning Systems (GPS) underlie recent innovations in the field of geospatial technologies (GSTs). Geospatial technology (GST) refers to equipment used in visualization, measurement, and analysis of earth's features, typically involving such systems as GPS, Geographical Information Systems (GIS), Remote Sensing (RS) and digital globes

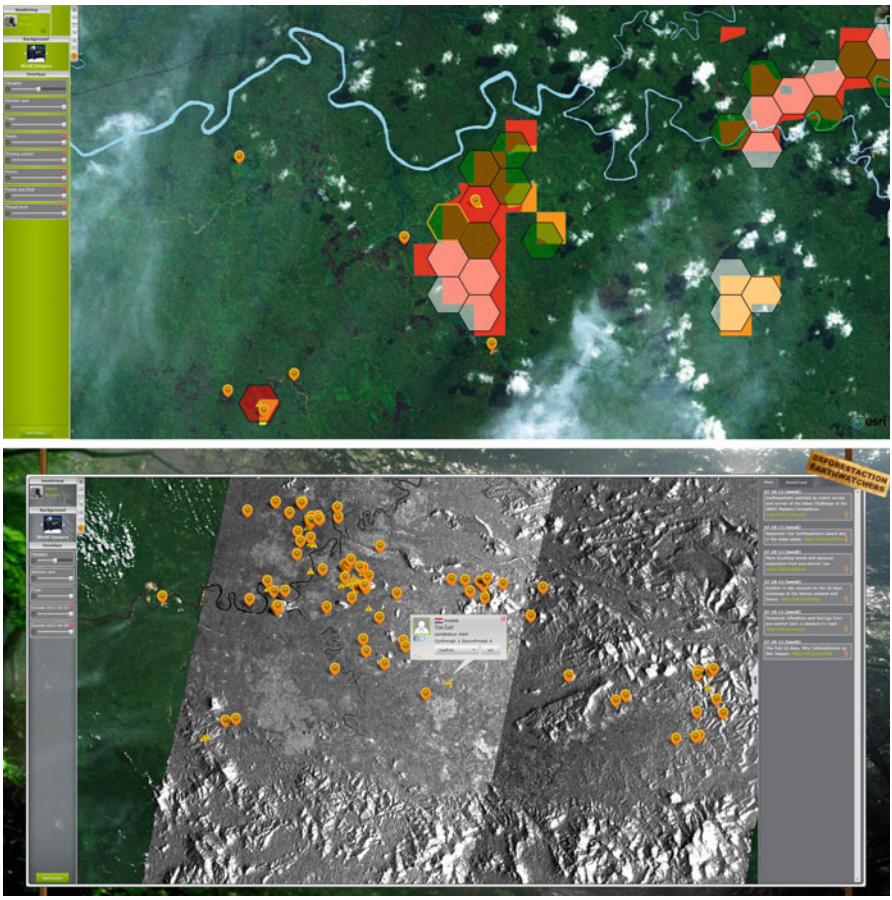

Fig. 2.1 Map of Borneo used by DeforestACTION (Screenshots van de Earthwatchers app; http://earthwatchers.cloudapp.net/)

(Cimons 2011; Baker et al. 2014). Geospatial thinking and GSTs can be situated in a framework of pedagogy, ICT, geography and science (Fig. 2.2).

Spatial thinking can be defined as a set of abilities to visualize and interpret spatial concepts like position, distance, relationships and change through space. Geospatial thinking is a specialized form of spatial thinking, focusing on patterns and processes that take place on or near the earth's surface (Baker et al. 2014). Geospatial thinking is also a specialized form of geographical thinking. GSTs are more and more the tools to help us in the process of thinking and learning about what is happening on planet earth.

But how useful and often fascinating the GSTs are, they are just tools. The core business for geographers is the questions they ask about what is happening on planet earth. Geography is concerned with human- environment interactions in the context of specific places and locations (Haubrich 1992), and with issues that have a

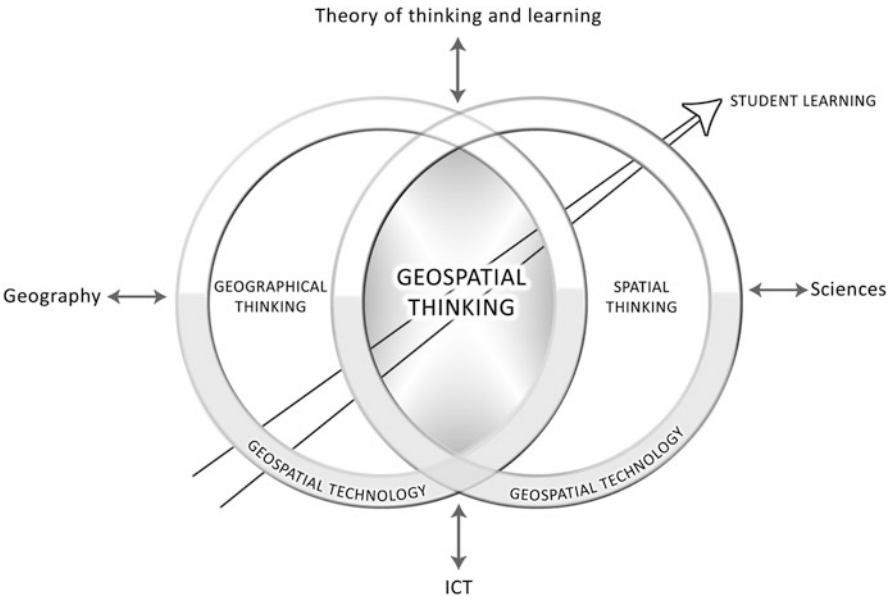

Fig. 2.2 A model to position geospatial thinking and geospatial technologies

strong geographical dimension like natural hazards, climate change, energy supplies, land use, migration, urbanisation, poverty and identity. Geography is a way of seeing places and thinking geographically to make sense of the world (Butt 2011). Using core or key concepts systematically helps us to think geographically (Geographical Association 2009). Place and space are the overall core concepts in geography. Every location and region is a place with its diversity in identity, history, people, and nature.

Every place (the 'local') is related to other places and regions, and moreover part of bigger regions (or countries) and the 'global'. Of course places are social constructions of people and can be seen from different perspectives. Looking from a spatial perspective the focus is on flows, mobility, relations, interactions, spatial pattern and networks, for example in trade, migration and communication. Place and space are supported by other key concepts, such as diversity, interdependence, scale, change and interaction (Taylor 2008; Lambert and Morgan 2010).

Geography education focuses on human-environment interactions and how they work out in different ways at different locations and helps us to get an overview of how life on planet earth goes on. GSTs offer 'Borneo-watchers', woodcutters, business men and policy makers unique opportunities to see what is going on and show that without geography we cannot make sense of the modern world nor make plans for its future.

2.3 Old and New in GST

GST started a very long time ago when people tried to explain a location or a good travel path to other people using a stick sketching a map in the earth or using stones to point out positions and routes. If you ask someone nowadays to show you the way, e.g. in Tokyo the shortest route to Asakusa from Kototoi Dori, big chance he or she will use a mobile phone to point out the direction on a digital map. Although some basic principles in learning with maps are still the same as a long time ago, today our instruments and our knowledge base have changed enormously. The use of GST is well-known and widespread in the military and hazard management, but its influence is pervasive everywhere, in such areas as land use, e-farming, retail planning and environmental protection.

From stick and stones via handmade maps and printed maps to digital maps was a long way. Computer hardware and software enabled the big leap forward from printed maps to digital maps. The first mechanical computers were developed in the nineteenth century, the first personal computers were introduced in 1980 by Sinclair Instrument Ltd. and IBM in 1981 (Fig. 2.3) and the Internet started to become available for the general public after 1992, when the introduction of the graphical web browser Mosaic meant a breakthrough of the hypertext-based World Wide Web.

After the invention of the printing press the introduction of the computer in combination with the Internet is a second big revolution in the world of learning and communication. "On our screens, on our phones, in our textbooks and magazines, our images of the world are changing faster than the world is itself" (Dorling 2012).

The terminology in the world of geo-information changes almost as fast as the development of the technical innovations itself. Many different terms alternate like New Media, Geo-ICT, GIS, Geographic Information Science, geomedia, geodesign, Volunteered Geographic Information (VGI), Web 2.0, Public Participatory GIS (PPGIS) and Neogeography. Until recently GIS was the most used word in geographical education for the activities connected with describing, analyzing and presenting digital geodata. GIS is defined by Burrough (1986) as "a collection of tools for collecting, storing, and visualizing spatial data about the world around us". More recently we see more and more user-generated content. The Internet is used by individuals to create and present their own world. This is where the term VGI comes in. Goodchild (2007) states that VGI has the "potential to be a significant source of geographers' understanding of the surface of the Earth". Citizens as sensors of what is happening on planet earth. A group of individuals collecting data responding to needs of a community or sometimes just for a hobby or fun. Although Goodchild sees a lot of advantages of the use of GSTs, for instance in hazard management, he also warns us to be critical. The reliability of data, the privacy of data, the digital divide and the vulnerability of the internet are important issues.

Borruso (2013) discerns nowadays a second revolution after the GIS revolution started during the last decades of the twentieth century. During the first revolution

Fig. 2.3 Sinclair ZX80 (1980) and first generation IBM PC (1981)

paper maps were replaced by digital maps that were used in inquiry-driven settings to foster knowledge acquisition. However, to analyze change temporally and spatially dynamic maps are required. Decision-makers use dynamic web maps to solve problems on a daily basis (Kerski 2013: 12/13). Digital maps evolved in cloud-based shareable maps. According to Borruso the so called Neogeography starts at the beginning of twenty-first century with citizens creating their own geography. This second revolution is made possible by the availability of a huge amount of free data, the fast diffusion of advanced laptops, tablets and mobile phones, low cost high speed internet with more bandwidth and a growing group of skilled computer users. In addition to VGI and Neogeography the name Web 2.0 is used to indicate that Internet users not just download information from the Internet but also interact and collaborate with each other using social media like blogs, wikis and Facebook. So what we see is hardware innovations, a fast growing set of easy available data and recently more and more communities of users that also create and present their own data.

2.4 New Opportunities and Challenges for Geography Education

For many of us using a mobile phone with GPS and geo-browsers such as Google Earth is as normal as eating every day. Life outside school without GSTs is for many of us inconceivable. Inside schools we see big differences in the use of modern GSTs.

Computer software offers great opportunities for learning and teaching geography as students and teachers have a lot of geographical data at hand in satellite images, maps and videos. As GSTs can be used in an interactive way they can also be very helpful in an educational system that advocates help students with different

abilities. The possibilities to find and to handle information in an interactive and very fast way are huge and booming. However, not everybody is optimistic about the new software that is available for geography education. Critical voices about the use of GSTs in education focus on the different weaknesses. First, in many schools in the world in less developed countries there are no facilities for using computers in the classroom. Hardware, software or even electricity is missing. Secondly, in more developed countries GSTs are entering classrooms slowly and often only recently as spatial technologies are not or are not well integrated in the curriculum and exams. Thirdly, most GIS and RS packages are not made to be used in education and many new geospatial technologies change so fast that it is not easy for teachers to find the time and energy to keep up with the latest and best innovation in a school context. And last but not least, most teachers are not trained to use GSTs in schools. They lack not only technological knowledge but also technological pedagogical content knowledge (TPCK) (Mishra and Koehler 2006). Of course the reality of GSTs in education is black nor white but everywhere different and changing. The use of smartphones is growing fast all over the world, web based GIS is less complex than it was, and a new generation of teachers that are digital natives is coming in. The more we are flooded by data and modern devices, the more urgent is the need to raise questions about the use and reliability of data. More important even is to find good ways to help students to give meaning to the fast growing amount of information in an era of fast developing technology. This brings us to the following needs and opportunities for training and research.

1. Practicing higher order thinking.

Outside schools young people are familiar with using geo-technologies but not in higher order thinking skills like structuring and analyzing (digital) information. This could be the added value of spatial thinking or geospatial thinking. Jo and Bednarz (2009) developed a tool to rethink the use of GSTs in geography education. Their taxonomy for spatial thinking has three dimensions: (1) concepts of space, (2) processes of reasoning, and (3) tools of representation. The taxonomy was developed and used to evaluate questions in four US high school level geography textbooks. The results indicate that textbook questions focus on low-level spatial concepts and textbook questions only rarely encourage higher-order cognitive skills. The study makes clear that it is good to ask the question what it exactly means to foster learning by thinking spatially or geospatially. Using GSTs is no guarantee for learning higher order thinking skills. The development of conceptual geographic frameworks to organize and structure information seems to be more relevant than ever. The question is how we can use GSTs to stimulate higher order thinking skills.

2. Meaningful learning using GSTs for studying regional systems.

Uhlenwinkel (2013) states that the competence of thinking geographically needs more attention in the field of GIS and spatial thinking. Information processing skills are often central in spatial thinking. If we focus more on thinking geographically ‘answering a geographical question’ and ‘giving meaning to the information’ are

added explicitly to information processing. This can help to simulate higher order thinking skills as students learn to study not only facts and concepts but also geographical relations within and between regions and regional systems. Kerski (2013: 25/26) states that asking questions and being inquisitive are critical to the successful use of web maps and GIS in education: "Through the use of these web mapping technologies, instructors can help students to begin analyzing the "whys of where" – the essence of geographic inquiry". Kerski emphasizes that asking about the whys of where is not the end of the story: "Students need to ask and grapple value based questions"……"This captures not only the heart of the spatial thinking, inquiry, and problem-based learning, but of education for activism – to make a difference in this changing world of ours".

The advantage of using GSTs to study regional systems is that they offer huge amounts of up-to-date data in a flash, often even in an interactive way. Google Earth, Street View, YouTube, Panoramio and other tools make it possible to zoom in on areas all over the world on a computer screen in 2D or 3D. In addition, web atlases can help to see patterns and processes in regions. GSTs do more than just give information. They also include tools to analyze information, e.g. to select certain phenomena or areas, to investigate relations between different phenomena within and between regions and to investigate and evaluate effects of decisions in an interactive way. Moreover, GSTs offer tools for the learner to be active and creative and GSTs are very helpful in visualizing plans and scenarios. So using GSTs we have at our disposal a well-visualized, easy, fast and interactive way to analyze and evaluate regional systems and regional development. Doing so, learners need to use higher order thinking skills.

The use of GSTs in education can be illustrated in different ways. As recordings of hurricanes and other disasters can be very shocking and help students to understand the impact of the power of nature, geospatial information available via GIS can help students to understand the causes of the event and to frame geographical learning (Sinton and Bednarz 2007; Fargher 2013). Other examples of the successful use of GSTs come from the local domain. Borián (2012) describes a project in which students in different European countries investigate, compare and explain the water quality in their local area. Using BISEL (Biotec Index at Secondary Education Level) students measured water quality and exchanged the results in a set of digital map layers. In conferences and through the internet students discussed the different results and geographical conditions. Fargher (2013) writes that PPGIS is "a promising way to further develop geographical understanding in schools of local issues because it attaches importance to deep local knowledge being of value in society".

Although many researchers, teachers and students report very positive about the use of GSTs there are some questions. First of all, there is not much evidence from research about the positive effects of using GSTs yet. Systematic studies in this field are necessary. Secondly, what we know so far is that students need more help and structure to frame the information they encounter. Favier and Van der Schee (2014) developed geography lessons about water management with GSTs using a serious game and a web GIS and compared them with conventional geography lessons that

had the same content. The research data showed that the lessons with GSTs were motivating for the students and contributed significantly more to the development of students' geospatial relational thinking than the conventional lesson series. However, higher order thinking skills were only partly acquired as most students had difficulty to evaluate the system of water management and its variables after the set of lessons. More structure provided by the teachers seems to be indispensable.

3. Teachers and their technological pedagogical content knowledge (TPCK).

Good geography teachers are needed to help students obtain geospatial thinking skills using GSTs. For innovations in education the teacher is the crucial factor and whether he or she will apply GSTs in teaching and learning will depend on external factors like the perceived need to do so and the perceived manageability as well as on internal factors like his or her professional geographical knowledge and motivation (Bednarz and Van der Schee 2006). Teacher training courses that focus on TPCK are still scarce, while we need teachers that can help students to see the wood for the trees and acquire the skills to ask critical questions about a fast changing world. The question is not whether to use GSTs or not but how to use them in a thoughtful and critical way.

2.5 Conclusion

GST offer rich opportunities for geography education and related disciplines. The danger using GST is to stick at a low level, the level of interesting pictures and maps. The challenge is to go beyond. Developing meaningful learning units that help to train students' higher order thinking skills is what we need to make optimal use of GST. Teachers play an important role here. That their geographical knowledge and understanding is crucial cannot be stressed enough.

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