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User-Centred Map Applications Through Participatory Design: Experiences Gained During the 'YouthMap 5020' Project

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In recent years, the concepts of usability, user experience, and user-centricity have gained in interest. Digital applications, developed in line with criteria related to these approaches, ask for a deeper understanding of users and their requirements. But, even though there is a wide range of methods available, the creation of user-centric applications with good usability and user experience still poses great challenges for developers. This is also true for web maps, i.e. web map applications, which today are ubiquitous on the Internet. They have evolved into an important information and communication tool and address users who do not possess any specific knowledge of Geoinformatics (GI) or Cartography. Despite the efforts made to meet the requirements and preferences of laymen, these users still often face problems when dealing with web map applications. This refers to aspects of design, content, and functionality. Here, participatory design, which is well-known in the field of Software and Web Engineering, might provide a suitable means. By engaging users directly and actively in the application development process, developers are able to gain a profound understanding of the users and their needs. However, there are several open questions regarding the use of participatory design for designing and implementing web map applications: What does the use of participatory design in web map development processes look like in detail? How and to what degree can users be involved in the development processes? Which added values exist? These questions are addressed by the project YouthMap 5020, whose main goal it was to create a prototype youth-centric web map for the Austrian city of Salzburg (zip code 5020). Applying the approach of participatory design, about 120 teenage pupils from several local schools were involved in all kinds of tasks related to the phases of generating the youth-centric Salzburg web city map. Experience and knowledge gained thereby allowed elaborating recommendations generally useful for generating youth-centric web map applications.

Keywords: web maps; software development processes; participatory design; usability; user experience; user-centric applications; the youth

INTRODUCTION AND RESEARCH QUESTION

Today, information and communication technology (ICT) has a huge impact on almost every aspect of our working and private life. It has begun revolutionizing fields such as education, transportation, banking, shopping, leisure activities, environmental protection, and social culture (Dapp, 2011; Primo, 2003). Due to aspects such as immediacy, interactivity, dynamics, up-to-datedness, mobile use, location baseness, combination of different media, and opportunities to contribute own content, ICT has changed the way in which people are informed, communicate, and collaborate. The role that computers, technology, and the Internet play in our life is further expanding in unexpected and unforeseen ways (Yardi, 2008; Zeleti and Mustonen-Olilla, 2011).

The rapidly growing relevance of ICT strengthens the call for good usability and user experience as well as increased user-centricity of applications. Generating applications which meet the criteria related to these concepts require thorough knowledge of the intended user group and their requirements, including tasks to be performed, the user environment, and the context of use (ISO, 2010; Nielsen, 1994; Richter and Flückiger, 2013).

To collect related information, a wide variety of methods and techniques originating from Software and Web Engineering, Usability Engineering, and Requirements Engineering can be used: user interviews and questionnaires, contextual inquiry, user observation, focus groups, card sorting, use cases, prototyping, literature review, analysis of analogue systems etc. These methods are widely discussed

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in literature (see e.g. Lowdermilk, 2013; Maguire and Bevan, 2002; Pressman, 2010; Richter and Flückiger, 2013; Sommerville, 2007; UsabilityNet, 2006).

Despite the plenitude of existing methods, it still is a difficult and challenging task to get to know and understand users and their requirements. The possible reasons are: misunderstandings between developers and users, developers' poor knowledge of the particular problem domain, users' incomplete understanding of their needs, users' failure in communicating their needs completely and expressing them clearly, and different, domain-specific vocabulary and technical terms used by users and analysts (Firesmith, 2007; Hull *et al*., 2010; Vijayan and Raju, 2010).

Participatory design is considered a useful approach in overcoming this challenge. By involving future users directly and actively in product design, i.e. the product development process, developers can gain a better understanding of the intended audience, and thus can implement user requirements more effectively (Muller and Druin, 2012; Sanders, 2002; Walters and Evans, 2011). By placing users at the centre of a development process ambiguity can be removed and one can get to the heart of what really matters to the users (Hennig and Belgiu, 2011; Lowdermilk, 2013).

The problems outlined above are as relevant for creating web map applications. Today, web map applications – which are great information and communication tools whenever spatial information is available – are pervasive on the Internet (Thielmann *et al*., 2012; Tsou, 2003). One reason for the steadily growing number of web map applications is the existence of a wide range of free and easy to use web mapping tools (e.g. Scribble Maps, Umapper, GmapGIS) and APIs (e.g. ArcGIS online, Google Maps, Bing Maps, OpenLayers). They facilitate the generation of web maps and web map applications by everyone (Ganson and Johnson, 2008; Highfield *et al*., 2011; Li and Gong, 2008; Nossum, 2012; Perkins, 2008).

Designing and implementing web maps, i.e. web map applications – that now more than ever should comply with the concepts of usability, user experience, and user-centricity (Atzl, 2015) – involves paying special attention to the users and their requirements. While Tsou and Curran (2010) state that user-centric web map applications provide both an effective user interface and a comprehensive map content, others outline the importance to know about devices to be used, the graphical user interface (GUI) design and the map design, map content, as well as the range and properties of functionalities etc. (see e.g. Freckmann and Huckriede, 2004; Kramers, 2008; Neuschmid *et al*., 2012; Nivala *et al*., 2005; Poplin, 2012).

From a cartography perspective, the map user has always played a central role in the traditional cartographic communication paradigm. Map makers are required to understand how maps have been used by different map users with different needs including map purpose, usage time, and required content (see e.g. Kraak, 2001). This is also the case in the development of web map applications (Tsou and Curran, 2010).

However, Tsou (2003) stresses that developers of web map applications are challenged addressing the needs of lay users who are a lot more diverse and unfamiliar compared to traditional users of GIS (Geographic Information System). They generally do not have specific knowledge of geographic information and cartography – which is often required in order to make full use of web map applications. As pointed out by Tsou (2003: 231), '… users may lack sufficient cartographic training to manage or interpret the dynamic representation of geospatial information'. In consequence, these users require solutions and support that developers are not aware of (Hennig and Vogler, 2014; Poplin, 2012; Tsou and Curran, 2010).

Regarding these problems, participatory design might provide the necessary support to create more user-centric solutions. But there are several open questions regarding the use of participatory design for designing and implementing web map applications: What does the use of participatory design in web map application development processes look like in detail? How and to what degree can users be involved in the development processes? Which added values exist? After giving some insight into concepts to address users (section 2) and youth-centric map applications (section 3) these questions are discussed based on experience gained through the project YouthMap 5020 (section 4, section 5). Section 6 closes the paper with a conclusion and outlook on future work.

CONCEPTS AND APPROACHES TO ADDRESS USERS

Related concepts

It has become critical for digital products to be tailored to users and their needs. The concepts of usability, user experience, and user-centricity have become of increasing interest in the software and web development domain. This is discussed, e.g., by Dapp (2011), Lowdermilk (2013), Walters and Evans (2011), and Yahaya *et al*. (2014). Criteria related to these concepts are presented in Table 1. Based on Burris (2014), ISO (2010), Lowdermilk (2013), Nielsen (1994), and Quasthoff and Meinel (2013) the interrelationship between the three approaches is discussed in the following paragraph.

User-centricity is a paradigm for various aspects of IT systems. The term addresses problems arising from computer systems that have become too complex, too unintuitive or too far removed from the actual user needs. However, user-centricity is not just about caring for users or asking users what they want a system to look like or to do. It is about understanding users, and collaborating effectively with them in order to make informed choices about what software to build. Owing to this, applications that are designed in a user-centric manner have higher chances of good usability. Usability is defined as a quality attribute of software products covering whether the system is easy to learn and to remember, efficient as well as effective and satisfactory to use. Usability thereby overlaps with user experience. Even though usability addresses aspects of user experience, the concept of user experience covers more than that. It is an even broader concept that includes giving people a delightful and meaningful experience while using an application. It encompasses all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours, and accomplishments that occur before, during, and after

Table 1. Selected criteria related to the concepts of usability, user experience, and user-centricity in line with software and web applications (based on EC, 2010; Fidgeon, 2005; Gugliotta *et al.*, 2013; Harvey, 2013; Hassan and Li, 2001; Nielsen, 1994)

Aspects related to software and web applications		Approach	Selected criteria/principles
Interactivity/Interactive design User interface design Information architecture Content (relevance/strategy) Media use etc.	→	User-centricity	Transparency, user control (data, privacy), simplicity, inductivity, multichannel delivery, user-friendliness etc.
	→	Usability	Flexibility, learnability, understandability, memorability, operability, attractiveness, safety etc.
	→	User experience	Likeability, fun, pleasure, comfort, trust etc.

using the application. Therefore, usability, user experience, and user-centricity focus on aspects such as user interface design, functionality, content strategy, interaction design, and information architecture which need to be developed around the user.

Background and introduction to participatory design

By definition, participatory design is a process that aims at directly and actively involving representatives of future users in the design or the development process of a system or product (Baek *et al.*, 2007). The intention is to bring user knowledge and skills (tacit knowledge; aspects usually not known to developers) into the development process by incorporating users, who are experts on their own requirements and needs. Working together with developers provides users with a voice in application development processes (Muller and Druin, 2012). This helps to generate applications which let users do whatever they aim to do in a better way (Muller and Druin, 2012; Steen *et al.*, 2007). Literature outlines a wide range of advantages related to the application of participatory design (Table 2).

Participatory design is not a new approach. Since its emergence in Scandinavia in the 1970s, it has increasingly attracted the interest of all kinds of product developers including software and web engineers (see e.g. Kautz, 2010; Sanders *et al.*, 2010).

The core idea of participatory design is interpreted in manifold manners and it is put into practice in different ways. Usually, participatory design is used within several mini-projects generating prototypes that feed into an overall project design process (Fidgeon, 2005). A distinction is made between weak and strong participatory design: In weak participatory design processes, even though user input is solicited, decision making is mainly undertaken by the developer team. In strong participatory design, users participate throughout the entire development process or even manage the entire development process on their own and take part in decision making. This refers to application content, design, and functionalities. Following O'Neill (2012), most projects that make use of participatory design concentrate on involving users in design activities only (weak participatory design), rather than on wider system development activities or the entire development process (strong participatory design). Further information on weak as well as strong participatory design can be found in e.g. Baek *et al.* (2007), Enerson (2013), Kensing and Blomberg (1998), Mazzone and Read (2005), and Steen *et al.* (2007).

Particularly strong participatory design requires appropriate ways to engage the intended audience (Sanders *et al.*, 2010). In order to enable holistic user integration, the use of procedural development models is considered most helpful (Peris *et al.*, 2011). Such models are commonly used in Software Engineering, where design and implementation of products generally follow well-known state-of-the-art processes, which are broken down into several stages such as requirements specification, application conception/

Table 2. Selection of advantages related to the application of participatory design (Ehn, 1993; Hekkert and van Dijk, 2001; Kujala, 2003; Peris *et al.*, 2011; Steen *et al.*, 2007; van Kleef *et al.*, 2005; Walters and Evans, 2011)

	Advantages
General	• Positive effects on quality and speed of the research and design process • Get to know users, and learn profoundly about e.g. their abilities, use purposes, user experience and (digital) competencies • Prevent and reduce communication problems (problems of misunderstanding) between developers and users related to vocabulary and technical terms, missing perspective on users' life circumstances and tasks • Toolkit of new ideas
Development process	• Obtain valuable user input • Address users unawareness on their own requirements and their incapacity to describe these reliably • Support developers to identify, describe and fully recognize user requirements • Deliver a stable foundation for the direction of the particular application development • Avoid undesirable developments
Afterwards	• Guarantee that the application is usable and that it delivers good user experience • Increase acceptance for the application in use • Ensure that the implemented product really meets the requirements of the intended user group, i.e. better match between a product and user needs or preferences and satisfaction

design, implementation, and evaluation. Examples for such development process models are the Waterfall Model, V-Model, or Spiral Model as presented and discussed by e.g. Munassar and Govardhan (2010), Pressman (2010), or Sommerville (2007).

For developers to draw full benefit from participatory design, it is necessary to involve as many of the future users as possible in the product or system development process. People involved should have different backgrounds, knowledge and experiences, and interests. Using findings from a study with a small number of participating target group members may result in a product that will interest only a few (Stewart and Williams, 2005).

YOUTH-CENTRIC MAP APPLICATIONS

In several fields, in which young people are the centre of interest, the youth is involved in the product development processes in one way or another (Mazzone and Read, 2005; Muller and Druin, 2012). Participatory design has started receiving interest since it helps to generate applications that are (more) responsive to youth's needs and their day-to-day reality (Kaufman, 2011; Mazzone and Read, 2005). Thus for instance, some domains such as the gaming industry especially focus on the interests of young people, which are – in this case – the main target group of a profit-based business model (see e.g. Pinelle *et al*., 2008). But despite this, as stated by Mazzone and Read (2005), most of the software that is aimed at young people is still designed with very little input from these users themselves. They are typically designed and built by adults who have little idea about the wants and needs of this user group when it comes to digital products. They are often generated based on what others say, on general assumptions of how the youths supposedly behaves, on what the youths needs and prefers, and on insights gained by developers observing their own children (Diwosch, 2009; Mazzone and Read, 2005; Nielsen, 2010).

This situation is also true for the geoinformation domain where many map applications for youths already exist (e.g. on a local scale in Magdeburg/Germany: www.jugendstadtplan.de or in New Haven/US: www.newhavenyouthmap.org and on a national scale in Austria: www.youthmap.at or in Germany: www.germany.travel/hotspots/map/germany), but applications particularly tailored to young people's concrete interests and developed together with them are largely missing. Moreover, recommendations that can guide the design and development of such applications do not exist and a closer in-depth look at youth-specific issues is still missing. Nevertheless, one fact is certain: young people's way of using web maps, their reasons and purposes for using web maps and web map applications, as well as their requirements differ remarkably from those of adults (Boswell, 2013; Diwosch, 2009; Nielsen, 2010).

A reason for putting a focus on children and the youths regarding web maps stems from the educational sector. To enable teachers to incorporate web maps in teaching, there is a need to provide usable tools and data. Some companies as for example the GIS market leader ESRI since years is engaged in fostering the use of spatial data in formal and informal education (see e.g. Tabor and Harrington, 2014). Accordingly, concentrating on youths as a very specific user group of web map applications includes a not only important – but so far – often forgotten target group. Co-operating with the youths can deliver important knowledge, useful for creating digital maps and spatial data products particularly tailored to education and teaching purposes. This could support initiatives from geoinformation companies and research studies which currently mainly focus on teachers' requirements when creating and implementing application suitable for education and teaching (see e.g. Höhne, 2014).

In this context, it has to be highlighted that the youth is quite a heterogeneous and complex user group. Covering an age span between approximately 12 and 20 (depending on the definition, i.e. the literature used), this encompasses several development stages related to different levels of skills, capabilities, abilities, and knowledge. Pertaining the use of ICT, the youth is described by the following aspects: (i) overconfidence in their computer and web abilities; (ii) reduced attention span, long reaction time, (iii) low patience level, quick judging; (iv) low willingness to read, e.g. use manuals; (v) low sophisticated research strategies, low willingness to explore implemented functionalities; and (vi) partly having problems to get and keep an overview (Boys and Girls Clubs of America, 1999; Diwosch, 2009; Loranger and Nielsen, 2013).

To overcome the lack of knowledge on the specific needs and interests of young people as a basis for (youth-centric) web map application development, it is very helpful to gather this information by using a participatory design approach. This is what YouthMap 5020 did.

THE YOUTHMAP 5020 PROJECT

Background of the project YouthMap 5020

YouthMap 5020 (http://www.youthmap5020.at) was a project led by the University of Salzburg (Department for Geoinformatics – Z_GIS) and funded by the Austrian Ministry of Transportation Innovation and Technology in the framework of the FFG programme 'Talente Regional'. The goal of this programme is to foster the connection between school education and academic research institutions. YouthMap 5020 aimed at strengthening the links between the geoinformation domain and education represented by the local school environment in Salzburg, Austria (zip code 5020). This was done by piloting a web map application for the city of Salzburg which not only was particularly tailored to the requirements and preferences of young people, but which also was developed by having the youth participate. The motivation therefore was based on the observation that the official online map of Salzburg addressed different target groups, fortunately also including the youth. But regarding its design and especially its content, this web map did not cater to the requirements of young people: The 'one fits all' approach of the Salzburg city map just tried to provide different information layers considered to

target the interests of different user groups, such as commuters, tourists, consumers, etc., and the youth. In consequence, the expected interests of the youth have been reduced to an information layer containing features like schools and advisory centres. But are young people really interested in that kind of (spatial) information? Some explorative short interviews with some pupils from Salzburg gave a clear answer: no!

To reach the goal of developing a new and more suitable youth-specific web map for Salzburg, the approach of strong participatory design combined with methods from Usability Engineering and Software, i.e. Web Engineering, was applied: With about 120 pupils aged between 12 and 18 years, from seven school classes (from six different local schools; Table 3), a preferably large number of teenagers with different backgrounds was involved in all tasks related to the design and development of this Salzburg city web map. The pupils participating in the project, which lasted the entire school year 2013/2014, were guided and supported by geoinformation experts from the scientific sector and the business and public administration domain. The experience gained thereby allowed devising recommendations to provide guidance to others creating youth-centric web maps.

Development of the YouthMap 5020 application

Development process and tasks. The modified waterfall model was used for the development of the YouthMap 5020 web map application. The modified waterfall model uses the same stages as the traditional waterfall model (requirements phase, design and implementation, testing and optimization), but stages are permitted to overlap. Since tasks can function concurrently a lot of flexibility has been introduced in the modified waterfall model (Munassar and Govardhan, 2010; Satalkar, 2010).

To fit the particular needs of the YouthMap 5020 project, the modified waterfall model was further adapted to the project needs. As shown in Figure 1 the YouthMap 5020 development process consisted of four major phases: (i) collecting and analysing user requirements; (ii) designing and building a (spatial) database as basis for providing youth-relevant map content; (iii) designing and implementing the web map application; and (iv) testing and optimizing it. Between those development stages, several feedback loops were integrated to adjust the results of former process stages to new findings while the application development went on.

Tasks related to the application development phases were carried out by the participating school classes. Each school class was responsible for a certain process step. Work activities, deliberations, discussions, and decision making etc. took place during different types of events:

1. workshops lasting up to serval days: each school class focused intensively on tasks related to a particular development process stage
2. 'working sessions': eleven pupils, i.e. two to three pupils from each school class (with a contract for work and labour) improved and completed the work begun by their school classes (e.g. revising user questionnaires, spreading user questionnaires, cleaning, and analysing the collected data, documenting results)
3. focus group meetings: the pupils involved in the 'work sessions' discussed open issues and made the 'final' decisions on e.g. requirements, content, design, and functionalities
4. project meetings: the pupils involved in the 'work sessions' exchanged about the work done and afterwards informed their peers about the outcomes of the meeting.

All work was supported by vivid communication between the geoinformation experts (University Salzburg) and the pupils. Asides from meetings and workshops non-face-to-face exchange took place. It relied on Facebook chat and a closed Facebook group. This form of communication was requested by the youth since they stated that they rarely use email. This behaviour conforms to findings in literature. Lenhart *et al*. (2005) outline that instant messaging has become the digital communication backbone in the daily life of young people.

In the different work steps and the communication cycle the geoinformation experts served as consultants and supported the pupils, but did not influence the discussions and decision making, both done by them independently.

Table 3. YouthMap 5020 project consortium

Partner		Description on tasks and role
Scientific	Department of Geoinformatics-Z_GIS, University Salzburg (Z_GIS)	Project lead Guiding the participatory design process Scientific support
Public administration	City of Salzburg, Youth Office	Real-world project- and product connection
Business	SynerGIS	Technological support (ArcGIS online)
Schools	Handelsakademie 2	Development of the YouthMap 5020 web map application: requirements specification, data collection, processing, management, map design and implementation, testing and optimization
	Bundesrealgymnasium	
	Akademisches Gymnasium	
	ABZ St. Josef	
	Sonder-Pädagogisches Zentrum 1	
	PH Praxis-Volksschule	

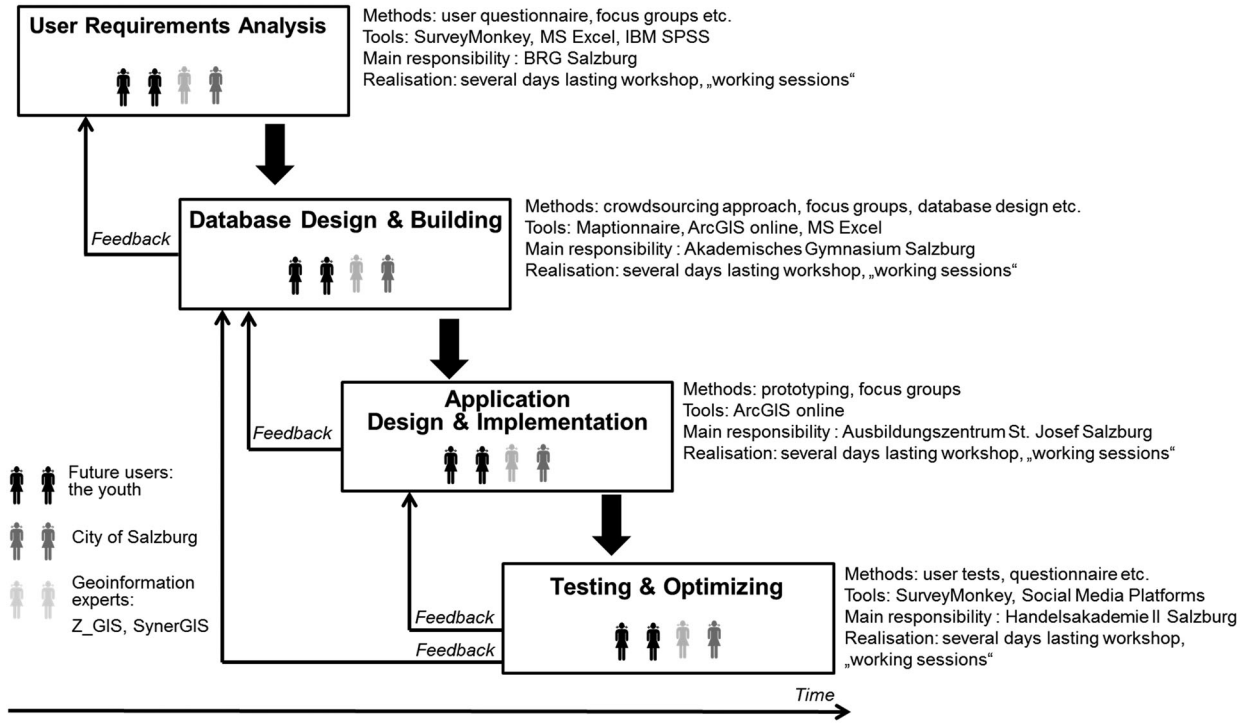

Figure 1. YouthMap 5020 development process model including stages, methods, and tools

Methods and tools. A wide range of different methods that are well-known and commonly applied in the context of participatory design as well as Software and Web Engineering was used throughout the entire YouthMap 5020 development process. In this context, the relevance of qualitative methods and data (e.g. a single but persuasive point outlined in a discussion) is at least as important as the result of quantitative methods (majority of questioned opting for one point). This is in line with findings from social and educational sciences: the exemplary qualitative in-depth structure of a specific use case and not its representability should be focussed to understand a specific and therefore unique phenomenon (Patton, 2014).

Collection of user requirements. User requirements were collected using two methods: user questionnaire and focus groups. The user questionnaire was conducted in autumn and winter 2013/2014. It was implemented as an online survey using the Internet survey tool SurveyMonkey (https://de.surveymonkey.com). The questionnaire consisted of 26 questions. Aside from asking for socio-demographic data (age, gender, school, place of residence etc.), the questions focussed on getting to know the youth's preferences on devices, GUI and map design, functionalities, and information demand (youth-specific points of interest (POI), urban infrastructure, facilities, and services). Pupils not only created the questionnaire, but they also spread it using different communication channels (face-to-face, Facebook, events etc.). They statistically analysed the data collected (about 600 responses with 502 valid response due to e.g. age restrictions) using MS Excel and IBM SPSS. In focus groups meetings several questionnaire results were discussed by the pupils.

Defining map content and establishing the (spatial) database. Some first details on information considered important by young people to be presented in a Salzburg city web map were given by the user requirements survey. This allowed distinguishing two categories of youth-relevant POI:

1. Youth-specific (i.e. trendy) places: e.g. where to meet and hang out, where to party, where to have a coffee or a drink, and where to eat something.
2. Points of general interest : e.g. public transportation infrastructure, taxi stands, tobacconists, free public WiFi hotspot (provided by the city of Salzburg), police stations and hospitals, public toilets, cash machines, and schools.

For the first category spatial and/or attribute data are not available per se. Applying a crowdsourcing approach, the data were collected using a map-based online questionnaire which was designed and implemented by the pupils using the Internet survey tool Maptionnaire (http://maptionnaire.com/). The data provided by Salzburg's youth (about 2.200 locations coming from about 200 pupils) were preprocessed (cleansed, re-categorized, aggregated etc.) using MS Excel and ESRI's ArcGIS online. The data were quality-checked (correctness, spatial accuracy etc.). Due to their 'expert knowledge' on youth-centric sites, the pupils were able to identify and correct errors.

Data belonging to the second group were delivered from the city of Salzburg (e.g. data on public transportation infrastructure) or were available as open data (Open Government Data etc.). All data were stored in a spatial database based on a specially developed data model.

Application design and implementation. Results of the user requirements survey (SurveyMonkey) and the map-based questionnaire (Maptionnaire) together with discussions in workshops and focus groups served as basis for the design and implementation of the YouthMap 5020 web map application pilot: (i) using appropriate base maps; (ii) creating appropriate symbols (specially designed and built by the pupils); (iii) offering useful feature pop-ups regarding content and design (font size and colour, paragraphs, photos, language used etc.); and (iv) ensuring the right level of functionalities. The prototype was built using ESRI's web mapping tool ArcGIS online. Easy-to-configure application templates (provided by ArcGIS online) were used to implement the web map application. Modifications necessary to fulfil user requirements were done by changing the application source code.

Testing and optimization. In a final step, the YouthMap 5020 web map pilot was tested by the pupils from the participating schools. Therefore, test scenarios and a short questionnaire were developed. Based on the test results the web map application pilot was optimized.

Additional work. To support and guide pupils throughout the development process, the geoinformation experts had to do some additional work : (i) prepare and lead workshops, focus group meetings, working sessions, and project meetings; (ii) define the workflow in detail; (iii) prepare material and manuals to enable pupils using methods and tools effectively and efficiently (e.g. ArcGIS online, SurveyMonkey, Maptionnaire, SPSS); and (iv) provide some background information based on literature review as well as analysis of analogue systems (e.g. on youth-centric applications and city web maps).

YouthMap 5020 pilot and selected recommendations

The YouthMap 5020 web map application (Figure 2) was designed and implemented with the youth strongly participating in all tasks throughout the development process. Together with findings of literature review, this resulted in a set of general recommendations for creating youth-centric web map applications (Table 4). The YouthMap 5020 application and the recommendations elaborated are presented in the following.

Devices. For different use purposes (entertainment, learning, doing homework, getting in contact with friends, gaming etc.) young people use different types of devices such as desktop computers, tablets, and smartphones (Boswell, 2013). Among these, smartphones have been receiving more and more attention in recent years. Smartphones are now owned and widely used by almost every teenager (e.g.

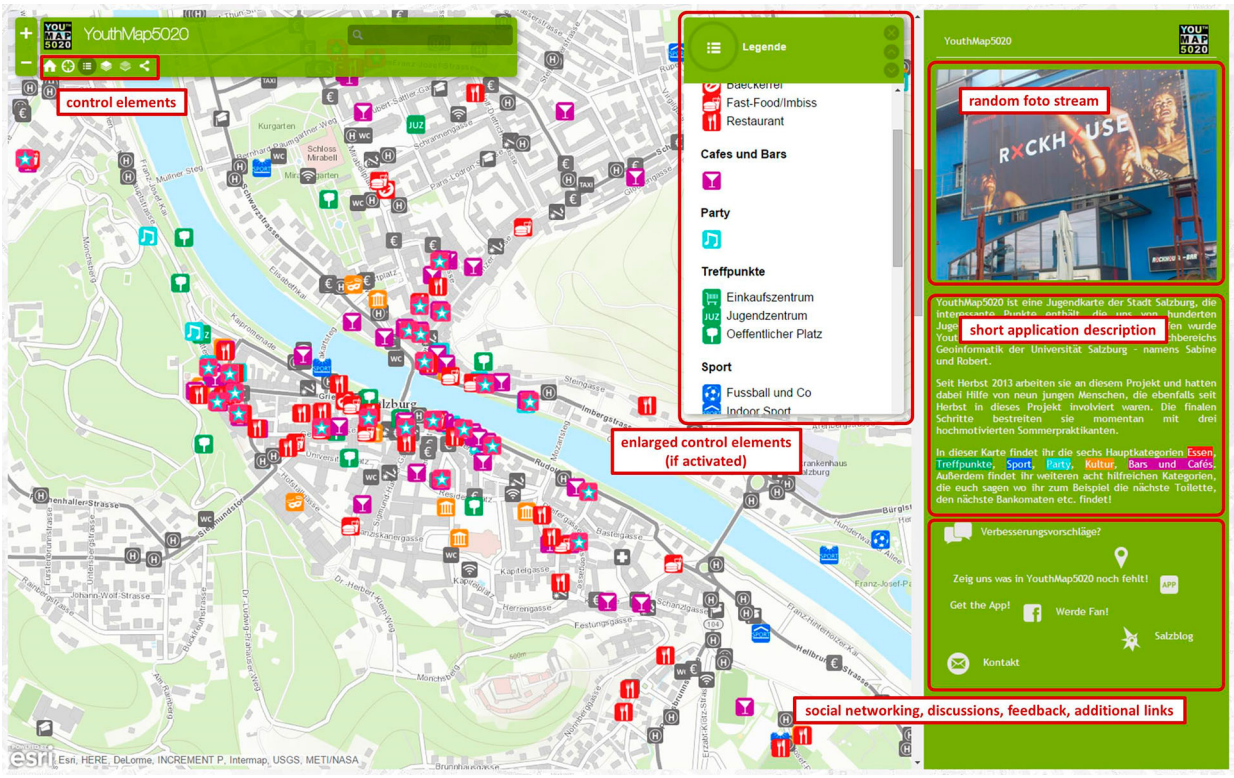

Figure 2. YouthMap 5020 web map application (desktop-PC version)

Table 4. Recommendations to guide the creation of youth-centric web map applications based on experience gathered during the YouthMap 5020 web map development process complemented with findings from literature review (based on Boswell, 2013; Downey *et al*., 2007; Gilutz and Nielsen, 2008; Idler, 2013; Lazaris, 2009; Loranger and Nielsen, 2013; Nielsen, 2010)

Recommendations	
Device	• Desktop computers • Mobile devices (mobile app considering aspects such as limited screen size, touch sensitive screens, GPS-enabled etc.)
Base maps	• First choice base map: street map; second choice base map: satellite image
Overlays	• Information on particular youth-relevant POI • Additional Information (popularity, price level, smoking areas, WiFi, age limit, peculiarities, URL, photo) • Avoid information overload • Allow users to change map content due to their information demand
Feature pop-ups	• Short sentences, good structuring (paragraphs) • Links easy to recognize as such (not just blue font colour) • Different text size to differentiate title, headings and text • High contrast between letters and background • Adequate, i.e. youth-specific language
Application design	• Well-arranged, simple, and intuitive interface; flat organizational application structure • Show important elements at a glance (e.g. no scrolling) and at first glance (e.g. no searching, clicking buttons) • Keep control elements accumulated (not spread over the interface) • Order elements to maximize performance, group items so that similar items are next to each other • No drop-down, nested, or overlapping (control) elements • Colourful, 'cool looking', modern design • Use meaningful language, no use of technical terms • Don't include tools unrelated to tasks users come to your site to do • Control elements, as many as necessary and as few as possible (reduce the complexity of the application)
Functionalities	• Limited, reduced number of functions, really suited to the needs of the target group as wrong types of functions prevent effective, efficient, and satisfactory working processes and as too many functions increase application complexity, decrease ease-of-use and scare users away • Typical and commonly known functions of interactive, dynamic web maps (navigate around the map: zoom and pan; address and location search; plan a route; turn layer visibility on/off; switch between different base maps; open feature pop-ups to access additional textual and/or multimedia information) • Social media functions (possibility for feedback, sharing etc.), but no profiles (registration)
User support	• Usable without consulting manuals, or other (readable) information • Appropriate labelling (no unknown terms, technical language)

for Germany: more than 84%; Bitkom, 2015). These devices are an expression of a new culture of conversation and social interaction closely related to the digital natives' way of online life (Downey *et al*., 2007; Elkind, 2003).

Thus, it is not surprising, that pupils outlined that the YouthMap 5020 web map application should be available on mobile devices as well: 45% of the user questionnaire respondents ($n = 502$) indicated that they want to use the application on a smartphone, 21% on a desktop computer, 20% on a tablet, and 13% on a notebook. Some pupils even said: 'If there's no app for it, I won't use it'. Owing to this, the YouthMap 5020 pilot was implemented runnable both on desktop computers (using the ArcGIS online template 'Basics') and Android mobile devices (using the ArcGIS online template 'Public Information').

Base maps. Regarding the use of base maps, discussions with the youth (workshops, focus group meetings) revealed gender-specific preferences. While boys were really excited about satellite images, girls found those very confusing. Nevertheless, the user questionnaire revealed a clear preference: of the 502 responses 414 (82%) voted for street maps. Hence, it seems reasonable to provide at least two types of base maps to choose from in youth-centric web maps: a street map (default: ESRI base map, alternative choice due to pupils' demand: Open Street Map) and satellite images (application fun/excitement factor).

Information provided via overlays. Initiated by the input of the user questionnaire and finalized in in-depth group discussions, the pupils defined 14 main categories with 28 subcategories of POI that matter to them and that had to be presented in the web map (Table 5).

Comparing information provided in the YouthMap 5020 web map application made by the youth to youth city web maps made by adults (see the examples in section 3.1), it became obvious how different young people's information demand is from what adults thought it would be. While for instance, adults consider advisory centres and youth engagement centres as important, for Salzburg's youth these aspects are less relevant. Adults pay less attention to party locations or youth-specific hang-out places, which are of central importance to the target group. Discussions during workshops and focus group meetings revealed that youths are very interested in information on safety issues. Indicating locations with a risk of thefts and fights on the map was highly demanded. This information is not presented in the YouthMap 5020 pilot: due to the current legal situation in Austria, it is a critical issue to provide such information on the Internet.

All in all, the youth demanded quite abundant information to be presented on the map. This requires strategies to avoid

Table 5. Overview on information demand (spatial data/overlays) as outlined by the youth

	POI main categories	POI subcategories
Particularly collected by the map-based questionnaire	Coffee shop/Bar	Coffee shop/Bar
	Food	Bakery
		Restaurant
		Fast food
	Party	Party
	Meeting places and sites to hang out	Public sites (incl. green space)
		Youth centres
		Shopping malls
	Culture	Events
		Library
		Cinema
		Museum/Gallery
		Theatre
	Sports	Indoor
		Outdoor
		Swimming
		Soccer & co.
Available by third party groups	Public transportation	Bus stops
		Suburban train stops
	Taxi stand	Taxi stand
	Tobacconist	Open day and night
		Open during daytime only
	WiFi hotspot	Free public WiFi hotspot (provided by the city of Salzburg)
	Police and hospitals	Police
		Hospitals
	Toilets	Toilets
	Cash machines	Cash machines
	Schools	Schools

information overload and scaring away users. Having maps overloaded with too many elements is a generally criticized aspect of maps (see e.g. Nivala *et al*., 2008). Thus, starting the YouthMap 5020 web map application, only two main categories of youth-relevant POIs are shown at first (most popular places so-called 'hotspots' and where to party). Using the layer switcher, users can change layer visibility. This control element is shown immediately when starting the application since the pupils indicated problems in terms of finding and using the layer switcher (Figure 3). This is underlined by the following statement of a pupil: 'I have to get it at first sight. Otherwise I'll skip and won't use it'.

Feature pop-ups. Depending on the category, different types of attribute data are available for the POIs. This information is presented to the users via feature pop-ups. Besides POI name and category this includes links to further information (websites offering e.g. contact data, open hours etc.), information on popularity (being a youth hotspot or not), photos showing the site, information on what is special there (peculiarities), price level from young people's perspective, age restrictions, availability of free WiFi, phone number, and availability of smoking areas. Decisions on providing this attribute data do not rely solely on the user questionnaire results. Several aspects which were not queried, i.e. revealed by the user questionnaire, where stressed by the pupils in vivid discussions (Figure 4; Table 6).

Regarding the feature pop-up design, besides plain text, links, and pictures are highly desired by the user group. Textual information should be presented in easy to understand language with short sentences, abundant paragraphs not using too small a font size, and bright colours (Loranger and Nielsen, 2013; Roßa and Dziallas, 2010). Since young people have difficulties in recognizing links as such (particularly for the younger ones blue underlined text doesn't vary much from other text; Diwosch, 2009), links used in feature pop-ups are presented in a more youth-suitable way, i.e. unequivocally highlighted and labelled.

Application design. Generally, the youths do not vary from other lay user groups regarding application design preferences (Table 2): Design should be kept simple and consistent, clearly laid out, and well-arranged. An intuitive user interface

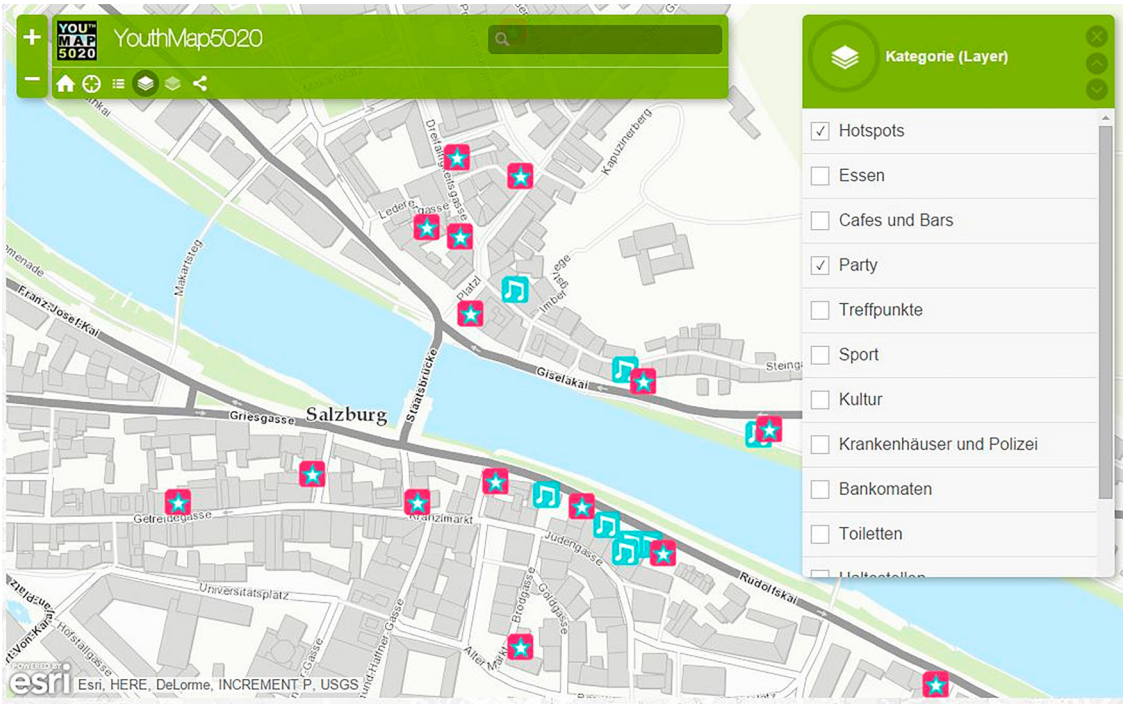

Figure 3. Overlays being visible to users in YouthMap 5020 when the application is started: party locations and places most popular for the youth

is required and implemented functionalities must be well-identifiable and straightforward to understand and use. Relevant elements must be found at first glance. This requires a simple structure, no nested GUI and map control elements, no scrolling and well-thought-out positioning of GUI and map control elements (see e.g. Neuschmid *et al.*, 2012; Nivala *et al.*, 2008).

However, in comparison to other user groups, young users ask for a fun and not boring design. Idler (2013) states that a cool and snappy visual look can trigger children's curiosity and it can motivate them to use applications. But what – from their point of view – does the youth consider an attractive design? In discussions pupils pointed out that the entire design must follow a modern look. When asked what they would define as a modern look, the first answer was: 'like Facebook'. Furthermore, it is known that young people – different to adults – prefer colourful designs and that they love bright, vivid colours (Lazaris, 2009; Loranger and Nielsen, 2013; Nivala *et al.*, 2008). This was confirmed by the pupils (user questionnaire, discussions etc.), and finds its expression in a quite colourful GUI and vibrant map feature symbols (Figures 2 and 3).

Figure 4. Discussion in project meeting: one authentic statement can sometimes be more valuable than user questionnaire results

Table 6. Provided attribute data based on quantitative and qualitative findings

Attribute data	User questionnaire results (n = 502)	Discussions (workshops, focus groups, meetings)
Link	For 57% of the respondents this is very important, or important	Providing further relevant information
Photo	For 90% of the respondents this is very important or important	'What is the site about'
Price level from young people's perspective	For 84% of the respondents this is very important or important	'We do not have so much money'
Age restrictions		'Prevents coming for nothing'
Popularity		'A nice to have'
Availability of free WiFi		'A must'
Phone number		A must for taxi companies, police stations, and hospitals (show the relevance of safety and security related issues)
Peculiarities		Supports decision making
Availability of smoking area	For 56% of the respondents this is very important or important	'For smokers and non-smokers it is a relevant detail'

Functionalities of interest. The YouthMap 5020 pilot provides functionalities typically implemented in web map applications: (i) map navigation (zoom and pan); (ii) switching between different base maps; (iii) turning layer visibility on and off; and (iv) providing (multimedia) context information (feature pop-ups). Other functionalities such as e.g. a (distance) measuring tool are not needed by the target group and therefore not integrated.

Additionally, pupils clearly highlighted the need for having common social media functions (i.e. social networking services): 60% of the user questionnaire respondents (n = 502) indicated this as an important or even very important feature. Owing to this, the YouthMap 5020 web map application provides possibilities to share the map object. Selected social media functions are implemented and allow publishing own content (e.g. provide additional POIs), discussing and commenting on the map and related issues (see the box in the lower right corner in Figure 2).

But, even though young users like forms of providing feedback and for asking questions, online voting, possibilities for sharing pictures, videos, or even map objects, and tools to maintain and establish online contacts, teenagers increasingly demonstrate (a high level of) awareness of Internet safety issues, e.g. protecting their identity online, withholding personal information (Downey *et al*., 2007; Loranger and Nielsen, 2013). This was confirmed by the pupils who preferred the map application and social media functions implemented and to be used without creating a profile.

User support. The youths generally refuse to use tutorials or any kind of information that needs to be read (Loranger and Nielsen, 2013). Hence, applications must be easy to use and to understand – without the need for any additional support. The following recommendations should be considered when implementing functions (Table 4): (i) reduced number of functions (to keep the GUI simple and clear); (ii) being intuitive, explanatory and understandable at first sight; (iii) use of symbols familiar to the youth; and (iv) important things should be directly accessible without pressing a button or scrolling.

The use of terms that are familiar to the audience also has to be considered. Unknown vocabulary scares users away from using applications, i.e. functions (Nielsen, 1995). Youths unfamiliar with terms such as *base map* or *layer* refused to click buttons labelled with these terms. (Comment: These terms are also frequently used to label the according control elements in applications in German language). To face this, the YouthMap 5020 web map application only makes use of (German) terms which teenagers *definitely* understand. Terms used were chosen by the participating pupils.

ADDED VALUES OF PARTICIPATORY DESIGN

Involving the youth actively and directly in the development process confirmed advantages of participatory design as listed in Table 2. This includes, for instance:

- Misunderstandings between geoinformation experts and teenagers could be reduced or even avoided: e.g. geoinformation experts became aware of missing knowledge and skills on the part of the youth regarding technical terms or geoinformation concepts and thus used other vocabulary.
- Co-operating with the youth helped developers to learn profoundly about this user group and allowed creating the application around the users and their needs: e.g. relevance of mobile devices, the way in which smartphones are used in daily life activities, problems using satellite images.
- A valuable foundation on user needs was attained by having youths participate in gathering and analysing user requirements: e.g. asking the right questions.
- User requirements were considered throughout the entire development process since the youths discussed and evaluated solutions as soon as available.

Knowledge gained about the youth and their requirements does not only refer to the artefacts of the various development process steps (Figure 1), but also by observing the pupils working (e.g. using ArcGIS online, problems encountered while doing this) and listening to them discussing and

Table 7. Problems faced while co-operating with the youth designing and developing the YouthMap 5020 web map application (based on documented qualitative observations)

Characteristic of the youth	Consequences for geoinformation experts/developers
Lack of work routine, work experience	• (Re)motivate the participants • Provide lots of explanations • Face and handle long discussions • Expect and face unreliability
Lack of experience in doing long lasting project work	• Be flexible: e.g. uncommon (online) discussions out of company time • Deliver an easy to understand big picture regarding the overall aim and workflow • Clearly structure and keep to the agreed workflow • Clearly define different tasks • Plan more meetings and roundups as usual to keep everybody up to date
Age-related level of soft skills	• Face impatience • Invite to experiment, i.e. think beyond common structures • Build up trust in pupils' skills • Help to carry responsibility • Support decision making without contributing own ideas or opinions • Help young people to express themselves (reasoning, presentations etc.) • Expect and deal with the problem of neglected deadlines
Age-related level of Technical skills	• Support the pupils in understanding the project structure, i.e. software development processes • Clearly express the importance of every work package • Express technical terms, vocabulary • Express technical concepts • Expect and deal with pupils' different knowledge backgrounds • Provide the suitable equipment (computers, software etc.)

developing ideas. Observation is one of the methods used in participatory design in order to draw further benefits from applying this approach (Mazzone and Read, 2005). The suitability of this method to research and understand map use and map users is underlined by e.g. Atzl (2015) and Perkins (2008). Advantages of participatory design are outlined in the following sub-sections based on the particular experiences made in YouthMap 5020.Further advantages of participatory design are outlined in the following sub-sections based on the particular experiences made in YouthMap 5020. Nevertheless, it also has to be stressed that collaboration with users and in particular with young people entails certain difficulties and challenges as well. Even though some of the problems listed in Table 7 are youth-specific, it shows which extra effort is required when applying participatory design. Nevertheless, it also has to be stressed that collaboration with users and in particular with young people entails certain difficulties and challenges as well. Even though some of the problems listed in Table 7 are youth-specific, it shows which extra effort is required when applying participatory design.

Learning from users

Working together with users in design and development processes can disclose new and unknown facets about the audience. Through the possibility to learn from users, participatory design provided added value as, e.g., outlined by Facer and Williamson (2004), Panne *et al.* (2003), and Steen *et al.* (2007). It might widen developers' horizon, inspire new ideas and let them invent innovative solutions.

Working with young people is considered to be particularly interesting, since today's children and teenagers are the first generation who has grown up with digital tools and with ICT as an integral part of their life. They learned to communicate, work, shop, and play in profoundly new ways by integrating ICT, they are incredibly aware of technology, and are often a lot more competent than adults when using new technology. Being accustomed to aspects such as using a multiplicity of communication modes, being permanently connected, immediacy, interactivity, constant (free) access to lots of information they think and process information in a very different way than previous generations. This is a tremendous change compared to older generations, who differ from digital natives in the sense that they must learn what digital natives grow up perceiving as normal (Cornu, 2011; Downey *et al.*, 2007). Elkind (2003) identifies several features of this new culture: it is speed dominated, screen-based, and information-focused, and a communication culture. But how can tools and in particular web maps, i.e. web map applications be designed to really be in line with the reality of digital natives? Involving the youth actively and directly in application processes can provide new ideas.

Throughout the YouthMap 5020 project some new ideas appeared which might trigger the development of innovative products. One example refers to using colour coding in the feature pop-ups and another one to combining social media and web maps. This is in line with Yardi (2009) who states that teens can help to design the next generation of social networking sites which may differ from the current ones.

Facing users' spatial literacy

Today, map handling increasingly refers to the use of digital maps, i.e. web maps and web map applications. To use digital maps in a competent capable manner, users require particular abilities and capabilities. Summarized by terms

Table 8. Selected competencies and skills necessary to use spatial data products in a competent and capable manner (adapted from Hennig *et al.*, 2013 and supplement by experiences gained during the project YouthMap 5020)

Selected skills and competencies	
Digital competencies	Register and login, i.e. self-representation, profile creation, identity management
	Use, create, remix, publish, share, embed content and objects (using different web 2.0 applications)
	Network (search for, combine, and disseminate information) and negotiate (travel across diverse communities, discerning and respecting multiple perspectives etc.)
	Work in a cooperative way
	Judge, i.e. evaluate the reliability and credibility of different information sources)
	Use of multimedia (find/create images, URLs, video/audio files; insert, embed, share, remix etc.)
	Internet safety issues including topics such as intellectual property rights, and data privacy
	Understand the logistics of cloud-based interleaving of services and media
Abilities to handle spatial data products	Know and understand base maps
	Use digital maps, i.e. map applications (find, open, zoom, pan, explore)
	Create maps and features (markers, lines, areas)
	Add further information (using information windows, i.e. feature pop-ups)
	Handle data files (import, export, convert, transfer)
	Output maps (print, save, export, embed)
	Re-use data (find data, assess data, integrate data)
Capabilities to handle spatial data products	Know relevant vocabulary and technical terms (e.g. pan, layer, base map)
	Cartographic design guidelines (internet, multimedia cartography): decide upon adequate symbols, map picture, background map, combine multimedia and geo-media
	Multimedia use (transfer data, post, comment)
	Critical reflection on the power of maps
	Use maps as a powerful mediator of particular interests

such as geo-media competencies or spatial literacy skills, this encompasses general digital competencies and skills enabling the users to communicate via spatial data products, produce their own spatial data products, and critically reflect on spatial data products (Table 8). In our society, these competencies and skills are still often missing. Literature stresses the relevance of educational measures (Gryl and Jekel, 2012; Hennig *et al.*, 2013).

While co-operating with pupils in the YouthMap 5020 project, geoinformation experts became sensitized to youth's level of spatial literacy. It became obvious that running such projects is a huge opportunity to improve pupils' spatial literacy: Being involved in the web map application development process, teenagers developed the above outlined competencies and skills. This occurred automatically since they were required to understand and use e.g. different tools (ESRI's ArcGIS online), and data sources (crowd-sourced data, open data). Pupils gained insights into the fields of GI (e.g. data types and formats, concepts such as the thematic layer approach, data quality problems), (digital) cartography (e.g. map components, visual parameters, cartographic communication) as well as Software and Web Engineering (e.g. development process models, development stages, and related methods). They learned about technical possibilities and constraints of ICT as well as the complexity of the work in which they were involved. These benefits are also outlined by Ehn (1993). As described by Walters and Evans (2011), pupils were impressed by the knowledge they gained (e.g. relevance of intellectual property rights; abilities to use several tools) and the interest in their results from outside (e.g. invitations to present 'their' product at several conferences).

Linking to a geo-digital society

Advances in ICT have paved the way for the emergence of a digital society, where digital information and communication are core concepts, and where actions are frequently mediated by digital tools (Dapp, 2011; Martin, 2008). Due to the advance and popularization of spatial data products, a spatially enabled society (see e.g. Enmark and Rajabifard, 2011) is now sometimes referred to as a geo-digital society (see e.g. Hennig and Vogler, 2014). This means that everyone in a society not only has spatial data products at his/her fingertips (e.g. geo portals, open government data), but also that everyone in the society presides over a certain level of spatial literacy allowing them to use spatial data products in a competent and capable manner and, thus, benefits from spatial data. This refers to aspects such as becoming spatially informed, producing, publishing, and sharing spatial data (e.g. user generated content, volunteered geographic information), and contributing to space-related questions such as citizen science projects or projects requiring public participation in GIS (see e.g. Hennig *et al.*, 2013; Poplin, 2012).

By involving users directly and actively in web map development processes, the YouthMap 5020 project supported the emergence of a spatially enabled, geo-digital society by linking the geoinformation domain to an everyday basis:

- As already outlined in section 4.2, pupils acquired competences and skills while participating in the development process. They gained insights into the multifaceted possibilities of spatial data products and were motivated to be more curious about such tools.
- Pupil's interests were attracted and they were sensitized to using spatial data products with regard to its relevance in everyday life, as well as the availability of spatial data and tools (e.g. purposes, potential of crowdsourcing approaches). Due to this – as outlined by Sui *et al.* (2013) – it will be more likely that they will use spatial data products in their private and school life activities – and later on in their work life activities
- The pupils co-operating in the YouthMap 5020 project acted as multipliers. At different events related to the project they not only told other teenagers about the project, but also proudly showed their work and explained related topics. Even beyond the project, they served as tutors in workshops held at their schools or at university events (e.g. special university workshops offered to pupils like GISDay). Here, it became obvious, that information and explanations presented by pupils as peers are more fruitful than comparting information by professionals, i.e. adults.
- Based on their experiences gained throughout the project, two of the participating interns wrote their final thesis on a geoinformation topic and thereby increased the visibility of the geoinformation domain at their school (note: every high-school student in Austria has to write a final thesis to take the high-school diploma).
- Finally, the project helped to establish a long-term cooperation with the participating schools, i.e. teachers and pupils, to sustainably gain the links between the geoinformation and the school education domains.

CONCLUSION AND OUTLOOK

Today, the general public is a relevant user group of web maps. In consequence, user groups and purposes of web maps and web map applications are quite diverse. In order to develop and design products which provide good usability and user experience and which are explicitly user-centric, users and their requirements must be well understood. Therefore, participatory design is a promising and interesting approach, which is in line with several research initiatives that highlight the necessity of involving the future users in application design and development decisions.

In the YouthMap 5020 project, participatory design and, first and foremost, strong participation (involving a rather high number of representatives of the target group directly and actively in all stages of a development process) helped to deliver an application which, in terms of device preferences (i.e. mobile devices, desktop computers), application design (i.e. colourful, no technical terms), content (i.e. youth-specific information demand), range of functionalities (i.e. integration of social networking services), aims at being (more) user-centric and providing increased usability and user experience. Asides from creating a youth-centric web map application through co-operating with Salzburg's youth recommendations providing guidance to others in developing such products were delineated.

Ultimately, using participatory design, the YouthMap 5020 project further delivered added values on (i) triggering the emergence of innovative ideas; (ii) the increase of people's spatial literacy; and (iii) the development of a spatially enabled, geo-digital society.

However, due to difficulties and problems related to the use of participatory design, success can be increased by involving 'mediators' such as teachers or pedagogues in the project consortium. Being trained to deal with pupils, they can help to further improve collaboration and communication between developers (experts) and pupils (lay users), e.g. moderate sessions, provide even more youth-adequate explanations, ensure that the information provided does not overwhelm the pupils. This allows disclosing additional opportunities and benefits related to participatory design. Thus, the YouthMap 5020 project can even more benefit from today's shift in attitude from designing for users to approaches which focus on designing with users.

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BIOGRAPHICAL NOTES

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