

Falling into a digital world: how are paper and interactive maps used by digital natives and immigrants?

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ABSTRACT Interactive maps are increasingly popular and have spread into everyday life. However, the pace of implementation of interactive maps may differ within different age groups. In order to adjust maps to user expectations and preferences, it is necessary to study disparities in attitude towards different types of maps in groups of various users. The aims of the study are to find out if the approach to maps of different media varies among age groups, and whether the frequency of use of interactive maps and their functions decreases with the age of users. A survey focusing on habits and preferences towards digital and paper maps was conducted among 80 users aged 20–72. Results suggest that the polarization of answers is lower than suggested by the Prensky theory of digital immigrants and natives: people of all ages who were tested have a lot in common in terms of interactive map use. Nonetheless, the youngest group has a strong preference for interactive maps.

KEY WORDS paper maps – interactive maps – digital natives – digital immigrants – preferences – map use – map medium

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1. Introduction

The media used for the transmission of information are changing; this has resulted in changes to people's habits, as a part of their activities have been transferred to virtual reality. Access to computers, smartphones, and the Internet is now ubiquitous and, as a consequence, digital maps have also become ubiquitous. Paper and digital maps may present the same information in different ways. The basic distinction between the maps is in the medium used for information transfer: paper or electronic devices. These changes cause divergences in the way maps are used. The discrepancy is even bigger when applying interactive techniques, which naturally refer only to digital maps (Kraak, Brown 2001). These have undisputed advantages, like data exploration, or being able to choose displayed layers. Interactive maps have become increasingly popular and have spread into everyday life.

However, the circumstances of the first contact with interactive maps, and then frequency of ongoing use may differ between users in different age groups. To adapt maps to the expectations and preferences of users, it is necessary to study the disparities in attitude between groups of users towards different types of maps. Prensky (2001) introduced the term *digital natives* in relation to discussion about education. He defined this group as being people born roughly after 1980, who have high levels of digital competency. Presumably, digital natives are considered to be users who are proficient in technology because it has been part of their lives since early childhood. He also proposed the opposite term, *digital immigrants*, people who have not grown up with technology, but started using it at a later stage in their lives. Prensky (2001) described the differences in behaviour and discrepancies in approaches to technology between digital natives and digital immigrants as, for example, the way in which people worked with text written on a computer – immigrants would prefer a printed version, whereas, digital natives preferred to read and edit text directly on electronic devices.

Age turns out to be an important factor when it comes to information and communication technologies (Li, Ranieri 2010; Ramanau, Hosein, Jones 2010). In terms of cartography, the divide between natives and immigrants can also cause differences between users, with popular and widely available sites such as OpenStreetMap and Google Maps (appearing respectively in 2004 and 2005) demonstrating a shift towards digital. The notion of digital natives and digital immigrants also seems to be interesting in the context of the different types of maps used among people in fields where the spatial component (spatial data and maps) is integral. We wanted to verify how users' ages affect their attitude towards, and their application of digital maps in everyday life.

Our aim was to answer the following research questions:

1. Do digital natives differ in their attitude towards paper and interactive maps when compared to digital immigrants?

2. Does the scope of activities in using interactive maps decrease considerably with users' increasing age?
3. What are the connotations associated with paper and interactive maps according to users of different ages?

By answering these questions we hope to contribute to knowledge about current map users: their preferences and habits. This may also indicate the way users evaluate paper and interactive maps, with special attention to the perceived advantages and limitations of the above-mentioned map types.

2. Related studies

2.1. Into the digital world

The ideas formulated by Prensky (2001) affected various scientific disciplines. They have prompted a number of studies that compare different age groups in terms of their digital competences. However, it turns out that the results were not always consistent with Prensky's theses.

Interesting results were obtained in studies exploring these issue in didactics, including higher education. Guo, Dobson, Petrina (2008) tested students of pedagogy in Canada, during the period 2001–2004, to verify how the age of the respondents related to information and communication technology (ICT) literacy. The results showed no statistically significant difference in ICT scores between digital natives and digital immigrants. The authors of the study concluded that the assumed disparities between these two groups may have been overestimated. Prensky's ideas (2001) were again tested in relation to university education in Canada. Students and faculty employees were asked about the implementation of digital learning technologies in the curriculum (Salajan, Schönwetter, Cleghorn 2010). Participants were questioned, for example, on their confidence in using technology, including electronic devices (e.g. laptops, the Internet, email). The differences between these two groups turned out to be minor. Moreover, Wang, Myers, Sundaram (2013) came to similar conclusions when they summarised the results of 36 papers on the digital fluency of digital natives and immigrants that were published during the period 2003–2011. Based on the results of this review, they advocated for the use of the term *digital fluency* instead of using a dichotomy.

When analysing digital natives only, it turned out that changes are visible between subsequent generations within this group. Joiner et al. (2013) compared the first (born after 1980) and the second generations (born after 1993) of digital natives in terms of their Internet experiences. The participants were undergraduate psychology students from six universities in the United Kingdom. Results showed

that the second generation used the Internet more frequently; for example, most of the first generation participants (63.3%) used email once or several times a week, but the majority of the second (86.3%) stated they used it several times a day. However, the differences within the digital natives group could result from individual preferences or socio-economic background. Gui and Argentin (2011) conducted research on the digital literacy of high school students from northern Italy. The results showed that the family's cultural background (understood as the parents' educational level) had a significant impact on operational skills. The differences in theoretical knowledge were based on the gender of the respondents, which the authors justified by referencing the variations in the interests of girls and boys. Gender was also an important variable, which defined the border of the digital divide between men and women, when it came to video games in a study conducted in the United States of America on undergraduate students (Terlecki, Newcombe 2005). Digital natives from the United States were also examined in terms of their use of social media (Williams et al. 2012). The Internet and social media turned out to be the main place young people sought and exchanged information. They used these sources daily for basic actions rather than for complicated operations, and did not feel the need to go beyond the elemental level of social activity. Young people claimed that they were satisfied with the scope in which they used technology and that the options available to them were sufficient.

In summary, Prensky's notion (2001) about the differences between digital natives and immigrants turned out not to be so clear when empirically tested in various fields and aspects. In fact, there is a noted fluency in technological application with digital natives, especially for the later generations. However, Salajan, Schönwetter, Cleghorn (2010) pointed out that research on the divide between digital natives and immigrants had been mainly carried out in developed countries (the United Kingdom and the United States) and that there is a need for similar research in countries with different developmental paths.

2.2. A shift in map preferences and use

Maps are important tools for data visualization and analysis. Thus, the process of map use has been carefully studied by cartographers for many decades (Montello 2002), and has led to attempts at ordering and classifying how map users work with maps, based on a theoretical approach (Roth 2012) or collected empirical data (e.g. Popelka et al. 2013, Havelková and Hanus 2019). The empirical testing has covered various issues (Štěrba et al. 2015), yet, there are still many challenges to be faced (Griffin, Robinson, Roth 2017; Griffin et al. 2017; Roth et al. 2017; Roth 2019). One of the important questions in cartography is how digital technology has affected map production and map use. Cartographic literacy is studied among

digital natives (i.e. pupils), in order to improve cartographic education (Hanus, Marada 2016) and, ultimately, to improve map users' skills and abilities when handling both paper and interactive maps.

Currently, it seems that map users are expected to work fluently with maps from different mediums, paper or interactive electronic devices, however, we cannot be sure if this is the case; and so this issue has been investigated across many aspects. Differences in digital fluency can also be evaluated when comparing the preferences and scope of the application of paper and digital maps. The results of a series of studies has shown a change in preference from paper to digital maps in the first fifteen years of the twenty-first century. A study by Pedersen, Farrell, McPhee (2005) carried out at the beginning of the twenty-first century, found that more than half of the respondents preferred paper maps. In the study, which was conducted in the United States, participants (students from various courses) completed tests for both paper-based and electronic-based map-reading skills. Next, they were asked about their map preferences and completed a *Learning Styles Inventory*. No differences in performance between paper and digital maps were found; nor any relationships between learning style, performance, or preference. However, all participants had a strong preference for paper maps. According to the participants' written comments, they had a negative attitude towards new technologies; and were mainly discouraged by the incompetence of the teachers and the slowness of the equipment. Surprisingly, respondents considered paper maps to be more interactive and easier to use in group work, and what is more, the possibility of obtaining an overview of the map was an important factor for them.

Different results were collected in three studies carried out around a decade later in the United Kingdom (Axon, Speake Crawford 2012; Speake, Axon 2012; Speake 2015) in which geography undergraduate students from Liverpool Hope University took part. The first survey, in which 46 first-year students participated, was conducted in January 2011. The second study was conducted in the months of January 2011 and 2012 on 84 participants. The last study was from December 2012 with 36 respondents. The studies were based on questionnaires with both open-ended and closed questions concerning the use, ownership, and experiences of navigation tools. All of them were analysed using descriptive statistics, but the study published in 2015 was enriched with a qualitative ethno-methodological approach, which allows researchers to get to know the history of the respondents in their own words. Respondents in the second study, by Speake and Axon (2012), expressed an unwillingness to use paper maps, and this was justified mainly by the difficulties experienced in using them. Such responses also prevailed in the third study (Speake 2015). The disadvantages most often indicated for paper maps were their lack of user friendliness and difficulty of use. In both studies, the majority of participants claimed not to use traditional, paper maps (they were considered 'useless') but, instead, preferred digital maps and navigation, which were more

interactive, easily accessible, and were said to give 'simple instructions'. What is important is that the respondents in the first study (conducted in 2011), often claimed that using navigation tools had a negative impact on cartographic skills and abilities to navigate when using different methods (Axon, Speake Crawford 2012). Interestingly, maps were not thought of as navigation tools (Speake, Axon 2012). For navigational purposes, the majority of the respondents preferred to use navigation devices, while their second most popular choice was to ask people for directions. Speake and Axon (2012) implied that, for young people, the traditional paper map was still their first association with the term map, and additionally suggested (2015) that navigation tools might be subsuming traditional maps. There may be several causes for digital maps substituting paper maps; it could be a result of the way people perceived the world, or simply that they had more experience with digital maps as they used computers and smartphones every day.

The same results, in terms of young people's preferences, were obtained in a study conducted among Japanese participants (Wakabayashi 2019). They also preferred navigation devices over paper maps. This study discussed the differences between generations with regard to the frequency of use of ICT devices and conventional maps. Participants were recruited from among the residents of Tokyo's metropolitan area, and were divided into age groups at 10 year intervals. As for differences in the frequency of various types of map use, the majority of young people often used roadmaps and navigation devices, while older respondents picked topographical maps as their most frequently used map. Another divergence can be observed when it came to the choice of web map application: young respondents chose Google Maps or Apple Maps, while older respondents preferred Yahoo! Maps. When it came to the choice of device, young participants preferred digital maps on smartphones, and older people favoured paper maps or maps displayed on PC's. When considering applications for smartphones, the most popular ones that used maps included those dedicated to navigation and sports-trackers (Do, Blom, Gatica-Perez 2011; Havlik, Schimak 2014). What is more, the role of applications with games that include GPS tracking has also increased in recent years (Boulos, Yang 2013).

When it comes to map use, differences can be observed between teenagers and adults. Lloyd and Bunch (2003) compared the process of using maps in young adolescents (11–14 years old, mean age 13) and adults (18–51 years old, mean age 23) in the United States. During the experiment, which was a simulation of working in GIS software, a map was displayed in the form of layers, parts of the map, and the map as a whole at different scales. After free exploration of the map, respondents took a test to check how much information they remembered. During the examination both correctness and response time were measured. Respondents also assessed their own level of confidence in answering each question. Young adolescents responded more slowly and less accurately, but were more confident

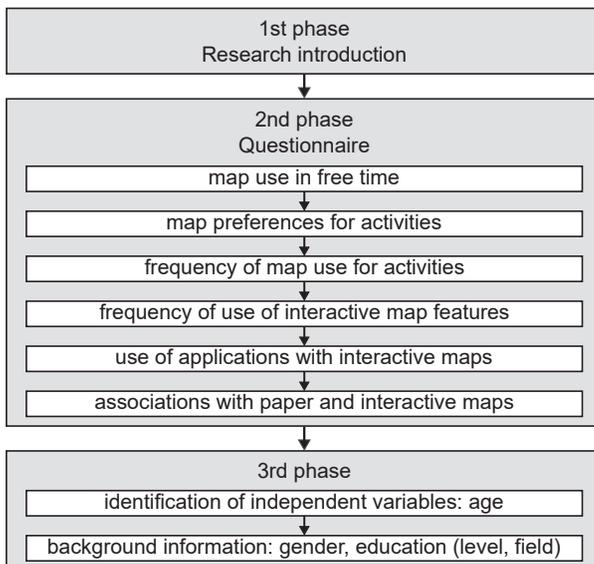
in answering than the adults were. According to the results of the study, it was easier to use the entire map than layers or parts of it, because the data was more integrated. The authors recommended that in education, a map that synthesises information, rather than GIS, should be used. However, for teenagers, the best combination of accuracy and self-confidence was achieved when the map was presented in the form of layers.

These disparities may not only be caused by the age of participants, but also by their background: culture (Stachoň et al. 2018, Stachoň et al. 2019) or experience. In a study carried out in the United Kingdom by Hurst and Clough (2013), a distinction was made between expert and non-expert users, where participants declared their expertise in the field of geography. Both digital natives and immigrants took part in this study. The group that was familiar with maps and cartographical skills preferred paper versions, while non-experts favoured digital maps; however, both groups agreed on using paper maps for navigation on foot, while choosing digital maps for road planning and checking information about selected locations. The second phase was a task-based user study, in which 12 participants took part (6 experts, 6 non-experts). The tasks, which consisted of route-planning scenarios, were completed using either Google Maps or paper maps. The difference between expert and non-expert was smaller in the case of digital maps.

To summarise: the change in map users' preferences is noticeable. At the beginning of the century, a reluctance to use digital maps was observable in the approach of some respondents, but nowadays the situation is reversed. Digital maps are assessed as being more accessible and easier to use. This may have been caused by technological advances and by the consequent improvements in gaining access to it. Again, studies on map medium preferences have been conducted mainly in Western, developed countries. Post-communist countries (e.g. Poland, Czechia) have had different paths of development, which has had an impact on their economies and societies (Sztompka 1996), and resulted, inter alia, in limited access to technology and electronic devices. The pro-democracy changes that took place in 1989–1990 (Eisenstadt 1992) were a turning point for the whole region; and is why the call by Salajan, Schönwetter, Cleghorn (2010) – to fill the gap in studies about the technological turn in countries with different paths of development – is still valid with regard to people's use of maps, and their preferences. What is more, the full scope of activities that can be carried out using interactive maps has not yet been analysed in relation to map users' ages.

3. Empirical study

The purpose of the research was to test how the attitude to paper and interactive maps changes with the age of users. We were also interested in whether the scope

Fig. 1 – The experiment's design

of activities performed using interactive maps decreased with the increasing age of users, and what associations the different age groups made with paper and interactive maps. A survey was conducted in order to verify these research questions (Fig. 1).

3.1. Method

In order to collect the empirical data, we chose to use a survey in the form of a questionnaire. This method allows self-reported information to be obtained (Fowler 2013), and substantial numbers of responses to be gathered in a short time. Another advantage is the possibility for using both open-ended and closed questions. Furthermore, the researcher does not have to interact with participants, and thus, does not disrupt the process of collecting responses. To get responses from the widest possible range of users we decided to deploy two ways of completing the survey: online (Google Forms) and paper. The paper survey was used to obtain responses from users who may not have been fluent with digital devices.

3.2. Questions

The survey contained a total of nine questions: six closed and three open-ended (Table 1). The first question concerned the types of maps used during free time.

Table 1 – List of questions (questions translated by the authors)

No.	Questions	Possible answers
1.	What types of maps do you use in your free time?	[multiple choice] paper; interactive; do not know/use
2.	Which map would you prefer to use for the following activities: planning – (1) walking (2) bike and (3) car route; navigation in the city – (4) known and (5) unknown; navigation across terrain – (6) known and (7) unknown; (8) localisation of object; (9) measurements (e.g. distance); (10) searching for additional information?	paper; interactive; do not know/use
3.	How often do you use a PAPER MAP to perform the following activities: planning – (1) walking, (2) bike and (3) car route; navigation in the city – (4) known and (5) unknown; navigation across terrain – (6) known and (7) unknown; (8) localisation of object; (9) measurements (e.g. distance); (10) searching for additional information?	daily; a few times a week; a few times a month; a few times a year; do not use
4.	How often do you use an INTERACTIVE MAP to do the following activities: planning – (1) walking, (2) bike and (3) car route; navigation in the city – (4) known and (5) unknown; navigation across terrain – (6) known and (7) unknown; (8) localisation of object; (9) measurements (e.g. distance); (10) searching for additional information?	daily; a few times a week; a few times a month; a few times a year; do not use
5.	How often do you use these interactive map functions: (1) show my location; (2) set the route; (3) share location; (4) share your data (e.g. route, photo); (5) distance measurement; (6) find a specific object; (7) find an object of a given type in the area (e.g. photocopying); (8) check the traffic along the route?	daily; a few times a week; a few times a month; a few times a year; do not use
6.	How often do you use the following types of applications that use interactive maps: navigation, games, sport-trackers?	daily; a few times a week; a few times a month; a few times a year; do not use
7.	What applications that include interactive maps do you use?	(open-ended)
8.	List the first three terms you associate with PAPER MAPS (adjectives)	(open-ended)
9.	List the first three terms you associate with INTERACTIVE MAPS (adjectives)	(open-ended)

Next, respondents answered three closed questions about their preferences and frequency of using paper and interactive maps for various activities, i.e. planning – (1) foot, (2) bike and (3) car routes; navigation in the city – (4) known and (5) unknown; navigation across terrain – (6) known and (7) unknown; (8) localisation of object; (9) measurements (e.g. distance); and (10) searching for additional information. The three following questions concerned the scope of their interactive map use. Participants were asked how frequently they used eight interactive map functions: (1) show my location; (2) set the route; (3) share location; (4) share your data (e.g. route, photo); (5) distance measurement; (6) find a specific object; (7) find an object of a given type in the area; (8) check the traffic along the route. The next question concerned the frequency of using applications that included interactive maps. The survey finished with open-ended questions: first respondents

were asked to list applications they used that included interactive maps. The last two questions consisted of writing exactly three terms that were associated with paper and interactive maps.

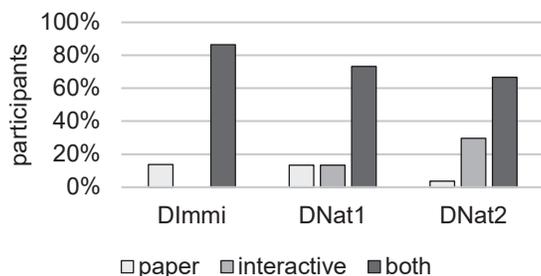
3.3. Respondents

A total of 80 respondents (41 women and 39 men) born between 1946 and 1996 took part in the study voluntarily. The median age of respondents was 31, all had higher education in the fields of geography, spatial management, or humanities, and all worked with maps and spatial data. The participants representing the humanities were historians who work with old and historic maps, as well as in historical GIS (hGIS). More than half (61%) had a master's degree, 26% a bachelor's degree, and 13% had obtained a PhD. Two different media were used in order to access the widest range of map users, an online survey, which was completed by 52.5% of respondents, and a paper survey, completed by 47.5%.

4. Data analysis

The respondents were divided into three groups: digital immigrants (born before 1980; labelled as 'DImmi'), first generation digital natives (born between 1980 and 1990; labelled as 'DNat1'), and second generation digital natives (born after 1990; labelled as 'DNat2'). Prensky (2001) pointed to the year 1980 as being the boundary between digital natives and digital immigrants; however, Poland was behind the Iron Curtain until 1989, so only those born after 1990 were raised in similar conditions to their peers from Western Europe or the United States. What is more, Joiner et al. (2013) argued that people born after 1990 grew up in the era of Web 2.0 technologies. Taking the above into account, it was decided to apply the concept of *generation* as a group of people born and living at the same time, as well as having common experiences and life perspectives (Merriam-Webster.com). The

Fig. 2 – Choice of map used during free time among digital immigrants (DImmi), first generation digital natives (DNat1), and second generation digital natives (DNat2)



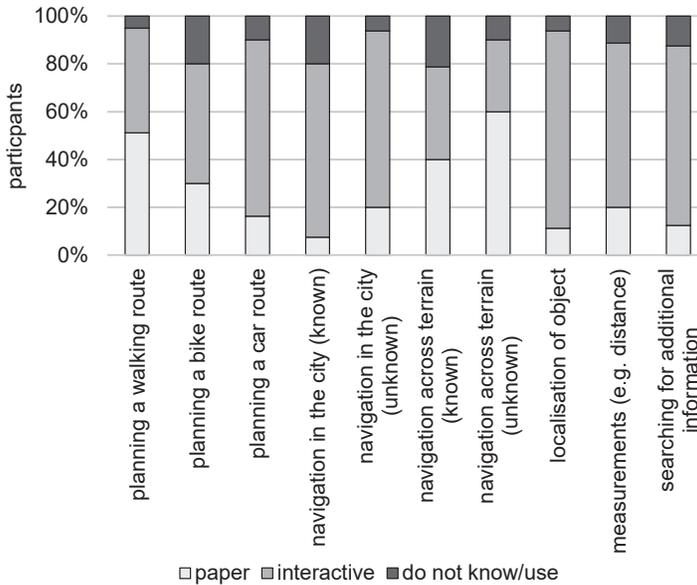


Fig. 3 – Percentage distribution of map preferences in terms of activities

groups had the following number of respondents: 22 digital immigrants, 30 first generation digital natives, and 28 second generation digital natives. A chi-squared test was performed to verify the distribution between age groups. The test was statistically insignificant ($\chi^2(2, N = 80) = 0.552$), which means that the categories for the analysed variable (age) were distributed in parallel.

4.1. Map preferences in terms of activities

All age groups used both paper and interactive maps in their free time. Cramér's V coefficient¹ showed that the choice of map used in free time was not statistically different in relation to age group ($t(79) = 0.244$; $p = 0.51$). However, none of the digital immigrants declared that they used only interactive maps in their free time; whereas, only one person from the second generation of digital natives stated they used solely paper maps (Fig. 2).

Respondents had to indicate which maps they liked to use to perform the various activities. These responses were grouped for statistical testing purposes as presented in the following sections. All generations strongly preferred the

¹ Cramér's V indicates the degree of association between the two variables. It is an extension of the chi2 coefficient for tables larger than 2x2 (Sheskin 2004).

Table 2 – Cramér’s V results for map differences in preferences between age groups in terms of various activities (tasks marked in *italic* resulted in statistically significant differences between ages groups)

Activities	Cramér’s V	p-values
<i>planning a walking route</i>	0.398	0.013
<i>planning a bike route</i>	0.286	0.011
<i>planning a car route</i>	0.297	0.007
<i>navigation in the city (known)</i>	0.320	0.002
navigation in the city (unknown)	0.238	0.060
navigation across terrain (known)	0.179	0.274
navigation across terrain (unknown)	0.226	0.085
localisation of object	0.224	0.091
measurements (e.g. distance)	0.110	0.750
<i>searching for additional information</i>	0.286	0.011

interactive solution (Fig. 3). The answer, ‘interactive map’, got more than 70% of votes for half the listed activities: planning a car route, navigation in the city (known and unknown), localisation of object and searching for additional information. Making measurements (e.g. distance) using interactive maps got almost the same amount of responses in every age group. Only in the case of two activities did respondents indicate a preference for paper maps: planning a route on foot (51% of respondents) and navigating in unknown terrain (60%). For two activities, navigating in a known city and navigating in known terrain, 20% of respondents stated they did not use any kind of map. The number of people who did not use a map in a known city seems rather low, and may indicate the level of the habit of using interactive maps on a daily basis.

The answers given for map preferences for different activities were compared between age groups. Cramér’s V coefficient showed that for five activities (1, 2, 3, 4, 10 – see Table 2) the differences were statistically significant ($p < 0.05$). However, the association between the age group and map preferences was moderate (results ranging from 0.286 to 0.398; see Table 2).

In terms of planning a walking route (1), digital immigrants showed a strong preference for paper maps. More than 80% of the group chose this option (Fig. 4). The younger the respondents were, the more they preferred the interactive solution. For responses to the planning a route activity (questions numbers 2 and 3), the replies were less diverse between groups. In terms of a bicycle route (2), more than half the digital immigrants chose paper maps. Digital natives had a similar percentage distribution of responses in favour of the interactive maps. When planning a car route (3), more than 75% of digital natives declared a preference for using interactive maps. Similarly, for navigating in a known city (4), they chose interactive maps, probably in the form of applications on a smartphone.

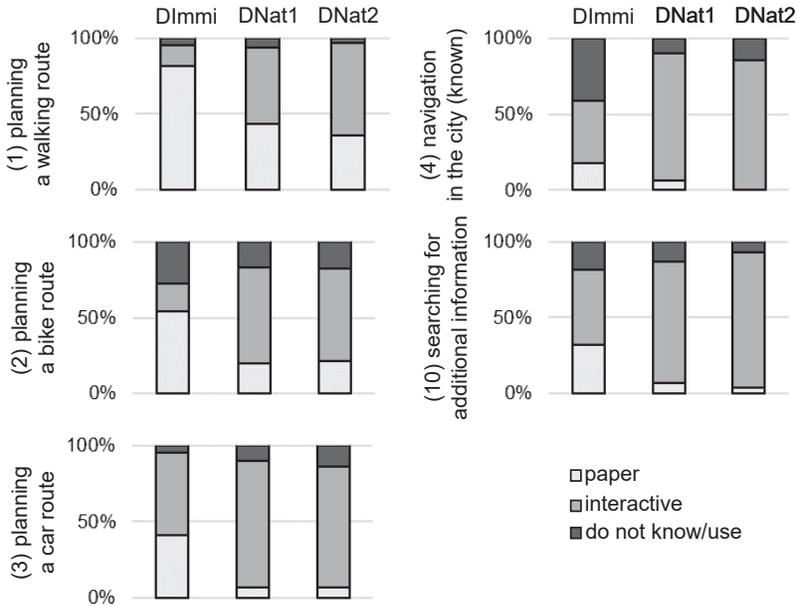


Fig. 4 – Percentage distribution of map preferences between age groups

Interestingly, 41% of digital immigrants indicated they didn't use a map in a known city; presumably, because they had been using the urban space for a longer time (Fig. 4).

4.2. Frequency of paper and interactive map use

In addition, the respondents had to specify how often they used paper and interactive maps when performing particular activities. Frequency of use was determined on a five-point scale: from (1) daily to (5) no use. In terms of paper map use the difference between age groups was statistically significant only in the case of (3) planning a car route (Table 3). When it came to interactive maps the results of the Kruskal-Wallis test² were statistically significant for the following activities: (1) planning a walking route, (2) planning a bike route, navigating in a (4) known or (5) unknown city, (8) localisation of object, (9) measurements, and (10) searching for additional information.

² The Kruskal-Wallis test is a non-parametric tests that can be performed on ranked data. The Kruskal-Wallis test allows for the verification of a significant difference between at least two groups in terms of the medians in the set of all analysed medians (Sheskin 2004).

Table 3 – Results of the Kruskal–Wallis test on the difference between frequency of paper and interactive map use between age groups (statistically significant results are marked in italic)

Activities	Paper		Interactive	
	Kruskal–Wallis	p-values	Kruskal–Wallis	p-values
<i>planning a walking route</i>	3.479	0.176	10.256	0.006
<i>planning a bike route</i>	4.485	0.106	8.635	0.013
<i>planning a car route</i>	9.568	0.008	1.241	0.538
<i>navigation in the city (known)</i>	2.247	0.325	10.889	0.040
<i>navigation in the city (unknown)</i>	3.371	0.185	12.741	0.002
navigation across terrain (known)	0.243	0.886	1.267	0.531
navigation across terrain (unknown)	4.243	0.120	2.862	0.239
<i>localisation of object</i>	0.848	0.655	12.693	0.002
<i>measurements (e.g. distance)</i>	0.935	0.627	7.864	0.020
<i>searching for additional information</i>	2.681	0.261	6.942	0.031

Understanding the differences between generations requires further analysis. According to Dunn's post-hoc test³, (3) planning a car route with a paper map was performed, statistically, more often by digital immigrants, and differed from both younger groups: first generation digital natives ($p = 0.031$); second generation digital natives ($p = 0.012$).

In terms of interactive maps, several cases required in-depth analysis (Fig. 5). When it came to (1) planning a walking route, the differences between digital immigrants and both generations of digital natives were statistically significant (digital immigrants and first generation digital natives $p = 0.006$; digital immigrants and second generation digital natives $p = 0.043$). In the case of (2) planning a bike route, the difference between digital immigrants and first generation digital natives was also statistically significant ($p = 0.015$).

When considering navigating in a known city, the responses of digital immigrants were, statistically, significantly different to those of second generation digital natives ($p = 0.003$); whereas with regard to an unknown city, there were statistically significant disparities between digital immigrants and both groups of digital natives.

The difference in the responses between digital immigrants and second generation digital natives were statistically significant (8: $p = 0.001$; 9: $p = 0.044$; 10: $p = 0.026$) for (8) locating an object, (9) measurements, and (10) searching for additional information. In each case the divergence was due to the oldest group indicating that they used interactive maps less frequently (Fig. 5).

³ Dunn's post-hoc test is also known as the Bonferroni test. The post-hoc test allows many groups to be compared, and indicates the groups between which means differ significantly (Sheskin 2004).

4.3. Interactive maps and tools

Participants were also asked to indicate how often they applied interactive map tools. Eight functions that were available in popular portals (e.g. Google Maps, OpenStreetMap) were included: (1) show my location, (2) set the route; (3) share location; (4) share your data (e.g. route, photo); (5) distance measurement; (6) find a specific object; (7) find object of a given type in the area (e.g. photocopying); and (8) check the traffic along the route. Frequency of use for these functions was determined on a five-point scale (from daily to no use).

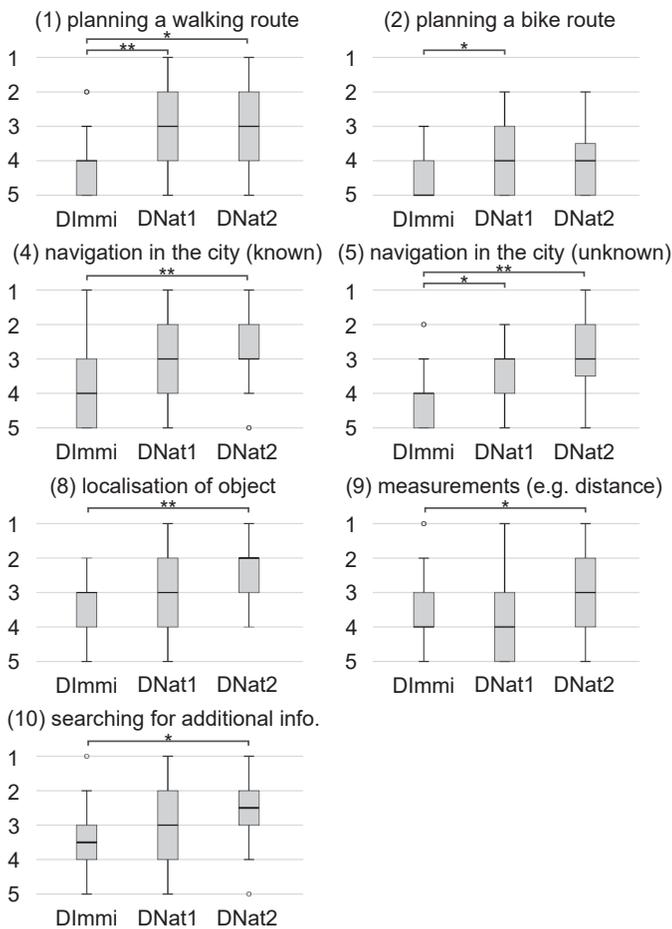


Fig. 5 – Differences in the frequency of use of interactive maps between age groups. The graphs only present the statistically significant results from Table 3. The horizontal lines above the graphs indicate statistically significant differences ($* < 0.05$; $** < 0.01$).

Table 4 – Results of the Kruskal–Wallis test on the frequency of use of interactive map functions for age groups (statistically significant results are marked in *italic*)

How often do you use these interactive map functions?	Kruskal–Wallis	p-values
(1) <i>show my location</i>	12.373	<i>0.002</i>
(2) <i>set the route</i>	16.198	<i>0.000</i>
(3) share location	3.504	0.173
(4) share your data (e.g. route, photo)	5.904	0.052
(5) distance measurement	2.732	0.181
(6) <i>find a specific object</i>	18.362	<i>0.000</i>
(7) <i>find an object of a given type in the area (e.g. photocopying)</i>	11.974	<i>0.003</i>
(8) check the traffic along the route	1.238	0.539

Table 5 – Types of applications that used interactive maps; use among age groups (statistically significant results are marked in *italic*)

How often do you use the following types of applications that use interactive maps?	Kruskal–Wallis	p-values
<i>navigation (e.g. Google Maps)</i>	15.859	<i>0.000</i>
<i>games (e.g. Geocaching, Pokemon Go)</i>	6.996	<i>0.030</i>
sports tracker (e.g. Endomondo, Runtastic, Strava)	3.219	0.200

In terms of four interactive map functions (1, 2, 6, 7), the Kruskal–Wallis test showed that the frequency of use of these specific interactive map functions across the age groups was statistically significant ($p < 0.05$) (Table 4).

According to Dunn's post-hoc test the differences between digital immigrants and digital natives were statistically significant in three cases (functions 1, 2, 6). For finding an object of a given type in the area, the difference in responses between digital immigrants and second generation digital natives was also statistically significant. In each case the divergence was because participants born before 1980 indicated that they hardly used most of the options (Fig. 6).

The frequency of use of interactive map applications was also included in the questionnaire. Three types of applications: navigation, games, and sport trackers were taken into account (Boulos, Yang 2013; Do, Blom, Gatica-Perez 2011; Havlik, Schimak 2014). The Kruskal–Wallis test showed that the frequency use of the various applications that had interactive maps for navigation and games, differed in a statistically significant way ($p < 0.05$; Table 5).

Post-hoc test results for the applications that were used for navigation show that digital immigrants differed from both generations of digital natives (Fig. 7). The reason is similar to that for the differences in use of interactive map functions: respondents in this group declared that they used them less frequently (once a month), whereas younger respondents claimed to use them at least once

a week. Interestingly, the answers for game applications showed that first generation digital natives differed from digital immigrants, who stated they do not use these kind of applications at all (Fig. 7).

In addition, respondents were asked to list the applications they used on their smartphones that used maps. More than a half the digital immigrants did not mention any, the rest named one or two. First generation digital natives named from zero to seven applications, while the second one listed from one to ten. All the groups most often indicated navigation applications such as Google Maps and tools for planning travel by public transport. Interestingly, three respondents from the second generation digital natives pointed to social media applications such as Facebook. Maybe people from this group spent more time on social media and due to this they were aware of more options.

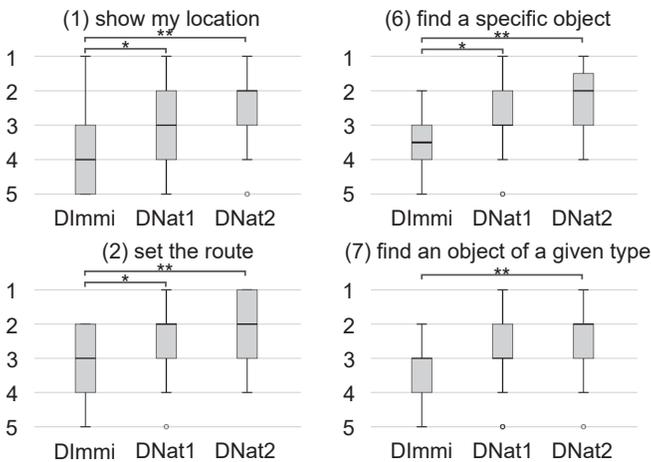


Fig. 6 – Distribution of the frequency of using interactive map functions between age groups. The graphs only present the statistically significant results from Table 4. The horizontal lines above the graphs indicate statistically significant differences (* < 0.05; ** < 0.01).

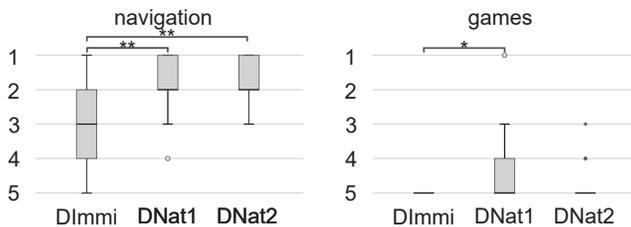


Fig. 7 – Distribution of frequency of use of applications that use interactive maps; use between age groups. The graphs only present the statistically significant results from Table 5. The horizontal lines above the graphs indicate statistically significant differences (* < 0.05; ** < 0.01).

4.4. Associations with paper and interactive maps

In the open-ended questions, respondents had to write down things they associated with both paper and interactive maps. They were asked for exactly three adjectives, however, some gave only one word, and what is more, nouns and verbs appeared as well. In total, 161 separate terms occurred in the answers provided by participants. The number of words appearing at least once differed between the age groups. Digital immigrants were the most uniform in their statements (Fig. 8).

For both types of maps, almost a half of the written associations were positive (paper map 46%, interactive map 50%). More negative statements occurred in relation to paper maps (19% of associations), than for interactive solution (8%). Neutral terms accounted for 35% of statements about paper maps, and 42% about interactive maps. Interestingly, negative statements in relation to paper maps (e.g. 'bulky', 'uncomfortable') appeared only among the digital natives' responses. Negative associations with interactive maps were mentioned only once among digital immigrants, and once in the first generation digital natives' group. The word clouds in Figure 9 show an overview of the differences in the frequency of word occurrence. Terms that occurred at least twice in one of the age groups were taken into consideration.

The associations that the participants listed were classified into qualitative categories based on two independently working coders (Table 6). Eight categories were distinguished: quality of presentation, quality during use, graphics, physical features, terms related to time, circumstances of use, technology, and conducted tasks (Table 6). Digital immigrants most often described maps in terms referring to the quality of presentation (above 30% of responses for both paper and interactive maps). This aspect of the maps decreased gradually in the descriptions provided by younger respondents. First generation digital natives focused mainly on quality of presentation (24%), and quality during use (28%); whereas the second generation

Fig. 8 – Number of terms used at least once by age group. (P – paper maps; I – interactive maps)

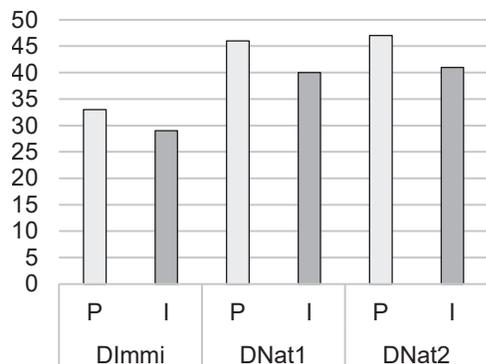




Fig. 9 – Positive (green), negative (red), and neutral (black) features associated with paper and interactive maps.

digital natives focused more on quality during use, especially when describing interactive maps. Paper maps were characterised by features referring to physical aspects and time.

Physical features were listed more often in relation to paper maps; for example, paper maps' large sizes was something that was repeated in each age group, however, digital natives indicated this most often. Another feature that occurred more frequently in terms of paper maps was readability (quality of presentation), which was important for digital immigrants and second generation digital natives. For

Digital immigrants		Digital natives (1st generation)		Digital natives (2nd generation)	
paper	interactive	paper	interactive	paper	interactive
<ul style="list-style-type: none"> readable colorful big reliable traditional comfortable detailed wireless accurate pretty habit 	<ul style="list-style-type: none"> available up-to-date fast small easy unreliable detailed 	<ul style="list-style-type: none"> accurate big available bulky handy outdated readable reliable folded pretty traditional demanding durable general easy old 	<ul style="list-style-type: none"> up-to-date available comfortable modern fast easy multifunctional unreadable navigation everyday handy zoom work 	<ul style="list-style-type: none"> big readable easily destroyed folded uncomfortable traditional accurate colorful bulky old outdated tangible reliable school light 	<ul style="list-style-type: none"> fast available comfortable handy modern intuitive interactive functional navigation accurate readable helpful online simple

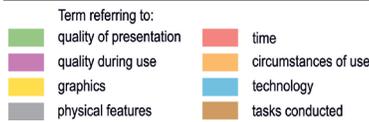


Table 6 – Features associated with paper and interactive maps

the middle generation, this feature was not compelling as only three respondents mentioned it. Interestingly, terms referring to graphics appeared only in relation to paper maps, and most often among digital immigrants (9% of responses).

The most frequently indicated feature for interactive maps was their availability (term related to technology). Digital immigrants and first generation digital natives also often pointed out that these maps were 'up-to-date' (quality of the presentation). Associations with tasks (e.g. navigation) appeared only in digital natives' responses and in relation to interactive maps. They also enumerated such features as 'comfortable' and 'handy', which referred to the quality of use as important aspects of interactive maps.

As for circumstances of use, the responses of each age group were different. Digital immigrants determined that paper map use was a habit, whereas, for second generation digital natives, this type of map was associated with school. First generation digital natives associated interactive maps with work and the daily use.

5. Discussion

In this study, three issues were analysed regarding different generations of map users, and the shift in attitude to both paper and interactive solutions was raised. The study also examined whether the range of activities performed using interactive maps was decreasing with the age of users, and if the age groups held different associations with the solutions.

In terms of map preferences for different activities, significant differences between age groups occurred in only 50% of the types of activities analysed. The responses of the two digital native generations were very similar and there was a noticeable inclination towards interactive maps in our study, as there was in the study by Wakabayashi (2019). Nevertheless, some digital natives opted for paper maps, or declared that they used both solutions, so their unwillingness to use traditional maps was not as strong as among respondents of the studies conducted by Axon, Speake Crawford (2012); Speake and Axon (2012), and Speake (2015). In general, however, the results are consistent with the study carried out by Hurst and Clough (2013), as respondents chose paper maps for planning walking routes, and a digital solution for car routes and searching for additional information. In terms of the frequency of using paper maps, the only significant difference between generations occurred in one activity out of the ten analysed – planning a car route; as digital natives stated, they hardly used paper maps for this operation. A more complex situation arises with interactive maps, where differences appear in as many as seven cases out of the ten analysed. However, in the case of four activities, the difference was only statistically significant when digital immigrants and second generation digital natives were compared. The responses given by

digital immigrants were significantly different to those given by both generations of digital natives in just two cases (planning a walking route, and navigating in an unknown city). For each situation the oldest group used interactive maps less frequently (from a few times a month to no use) than the younger respondents (from a few times a week to a few times a year).

When it comes to frequency of use of interactive map functions, a significant difference occurred in four of the eight analysed cases. The digital immigrants' answers to options such as: show my location, set the route, and find a specific object contrasted with the answers from both the younger generations. Again, the reason was that they used them much less often – a few times a month or year, whereas digital natives stated they used them a few times a week or month. The function, find an object of a given type in the area, was also included in the results for this question, and here the digital immigrants differed only with second generation digital natives. Less frequent use of interactive maps by digital immigrants also came out in the case of questions about applications. Again, people born before 1980 stated they used navigation tools a few times a month on average, whereas digital natives declared they used them a few times a week. This result corresponds with the studies by Axon, Speake, Crawford (2012), Speake and Axon (2012) and Speake (2015), in which students favoured digital maps for navigation purposes; but also with the study by Wakabayashi (2019). Interestingly, no divergence between respondents was found regarding sport trackers.

In relation to terms associated with paper and interactive maps, the groups varied as to the most frequently indicated terms. This may suggest that different features and aspects of map usage were important for each group. Although the digital natives' opinions on interactive and paper maps differed from the study by Pedersen, Farrell, McPhee (2005), young respondents, in both cases, used similar terms regarding interactive maps: they described them as fast and easy, and mentioned operations such as the zooming function.

Intriguingly, the differences between generations of digital natives that appeared in the study by Joiner et al. (2013) on Internet usage, did not occur among participants in our study concerning maps. However, in the study by Joiner et al. (2013) a different timescale was employed, as participants could choose between never, less than once a week, once a week, several times a week, once a day, and several times a day. For activities performed using a map, respondents were able to choose from a wider timescale, as some of the operations (for example, navigating in an unknown city) had a lower frequency of occurrence than others (for example, using email).

On the basis of the collected data, a significant divergence between digital natives and digital immigrants cannot be claimed. This corresponds with the results of studies by Guo, Dobson, Petrina (2008) and Salajan, Schönwetter, Cleghorn (2010), who concluded that the role of age is overestimated.

6. Conclusion

In this study we aimed at gaining an insight into the differences between paper and interactive map use and preferences for three age groups: those born before 1980 (digital immigrants), those born between 1980 and 1990 (first generation digital natives who lived their childhoods in a country run by a communist government), and those born after 1990 (second generation digital natives born into a democratic and capitalist country) (addressed in RQ1). Based on the data we gathered, a divergence occurs in a number of the analysed cases, but we cannot state that it is the rule that digital natives and digital immigrants always select certain, contrasting options. Concerning the choice of paper or interactive maps, we have proved that there was a significant difference between users of different age groups in five out of the ten indicated activities. Similarly, the frequency of choosing paper or interactive maps for specific tasks also differed across age groups only for some of the actions. The age groups differed more often when indicating the frequency with which they worked with interactive maps (7 activities out of 10), than when using paper maps (noted difference between age groups in only 1 out of 10 actions). This suggests that the paper map has not been replaced by the interactive solution, rather it has been supplemented by the wider functionality of interactive maps, which is not offered by paper maps.

Similar results were collected for the data that addressed the differences in the scope of activities that used interactive maps depending on users' ages (RQ2). Again, only some of the offered functions differed significantly between age groups. Only half the analysed interactive functions were used more often by digital natives than by digital immigrants. Similarly, two out of three suggested types of interactive tools were used more often by digital natives than by older map users.

When considering the terms associated with the maps (RQ3), we can state that maps, both paper and interactive, had positive associations for respondents. However, participants in different age groups referred to different features of the maps. Digital natives often characterized paper maps by physical features (e.g. 'folded'), whereas older participants referred to the way they were presented (e.g. 'readable'). In turn, digital natives characterised interactive maps with impressions about the process of use (e.g. 'fast', 'comfortable'), while digital immigrants focused on technology-related aspects (e.g. 'available') and – again – on the content (e.g. 'up-to-date').

We can sum-up by saying that there is no clear cut difference between the attitude of digital natives and digital immigrants towards paper and interactive maps. In fact, there are some activities for which younger users favour interactive maps, in contrast to digital immigrants, but the whole picture is not as clear as could be expected, based on Prensky's theory (2001). The results we collected do not

clearly reflect the processes of implementing new technologies, as users tend to adopt new solutions depending on their needs and preferences, not only their age.

Contact with interactive maps seems to be unavoidable for everyone. Older map users may, but do not have to, be more resistant towards new solutions. However, the preference for interactive maps across the generations of digital natives was noticeable. Presumably, this is related to Prensky's (2001) thesis: that this is a more natural solution for them, because they have had more access to interactive maps for a greater part of their lives than have older users.

Interestingly, in some cases there was no divergence between digital immigrants and first generation digital natives, although the difference in responses was significant between digital immigrants and second generation digital natives. The impact of changes in the political and economic situation on differences in digital fluency between generations requires closer analysis and study.

In analysing the quality of the data, we can mention that a higher number of participants may have been desirable. However, as reported above, a number of successful studies investigating the issue (e.g. Speake, Axon 2012, Williams et al. 2012, Speake 2015) have already brought forth meaningful input, and had a similar number of respondents. We also believe that the study reported here may be a starting point for investigating this problem on a larger scale. Another limitation could have been caused by narrowing the respondents to those who had contact with maps due to their expertise. We hope that our study will cultivate discussion about the needs of map users, and that it will contribute to further in-depth research on this subject.

We hope that our study has shed some light on the differences in map use and map preferences between different generations of users, and provided further verification of the notions of digital fluency in cartography, especially in those countries who have had different paths of development to Western, developed countries.

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