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USING MAPS FOR CARTOGRAPHIC EDUCATION IN THE AGE OF SMARTPHONES: PERSPECTIVES OF FUTURE PRIMARY SCHOOL TEACHERS

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Izvleček/Abstract

The widespread use of smartphone navigation impacts the role of paper and digital maps in developing primary school cartographic literacy. This study examined how 129 future primary teachers perceive maps and intend to use them. A mixed-method survey was conducted at the University of Ljubljana, Faculty of Education. Findings show participants prefer mobile maps daily but advocate combining both formats in education. They recognized the value of paper maps for spatial thinking and independent orientation, alongside the practical benefits of digital alternatives. The results support a balanced pedagogical approach integrating both media to foster cartographic literacy and essential digital competences.

Uporaba zemljevidov pri kartografskem opismenjevanju v dobi pametnih telefonov: perspektive bodočih učiteljev razrednega pouka

Vse večja uporaba navigacije na pametnih telefonih sproža vprašanja o vlogi tiskanih in digitalnih zemljevidov pri razvijanju kartografske pismenosti in prostorskega razmišljanja v osnovnošolskem izobraževanju. Raziskali smo, kako bodoči učitelji razrednega pouka uporabljajo in zaznavajo tiskane in mobilne zemljevide ter kako bi jih uporabili pri poučevanju. V anketi z mešanimi metodami je sodelovalo 129 študentov dodiplomskega študija programa Razredni pouk na Pedagoški fakulteti Univerze v Ljubljani. Ugotovitve kažejo, da udeleženci v vsakdanjem življenju dosti raje izbirajo mobilne zemljevide, v osnovnošolskem izobraževanju pa zagovarjajo kombinacijo obeh. Izsledki podpirajo uravnotežen pedagoški pristop, ki povezuje oba medija z namenom spodbujanja kartografske pismenosti.

Keywords:
cartographic literacy, paper maps, digital maps, mobile navigation, spatial thinking, primary teacher education.

Ključne besede:
kartografska pismenost, tiskani zemljevidi, digitalni zemljevidi, mobilna navigacija, prostorsko razmišljanje, izobraževanje učiteljev razrednega pouka.

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Introduction

Various portable devices are used for map reading and spatial orientation: smartphones, smartwatches, PDAs, or wearable devices such as headphones, even shoes or belts (Sugimoto et al., 2021). Consequently, traditional paper maps may appear less attractive to students who are accustomed to digital technology. Electronic or digital mobile maps offer many advantages, providing technical solutions that are not possible with paper maps and are familiar to younger generations. To avoid conceptual ambiguity, this study distinguishes between four terms: paper maps, digital maps, electronic maps, and mobile maps. Paper maps are static, printed cartographic media that require users to interpret spatial relationships and navigate without assistance. Digital maps refer to geospatial data stored in systems like GIS, where information can be processed, analysed, and transformed. Electronic maps are the visual display of cartographic data on digital devices, even if originally derived from paper maps. Mobile maps are a specific category of maps designed for mobile devices, often using GPS and real-time navigation, and can be either digital or electronic, including electronic copies of digitized paper maps. Overall, digital and electronic maps refer to different conceptual layers of the same cartographic system: data storage and processing (digital maps) versus data visualization (electronic maps). Understanding these differences helps educators select and combine cartographic media that best support specific learning objectives and promote comprehensive cartographic literacy.

However, the question arises as to what positive and negative effects diverse modern technologies and the use of navigation may have on cartographic literacy and the development of young people. Therefore, despite the widespread use and popularity of modern technologies, their educational application should be carefully considered before being fully integrated into teaching practice. Indeed, several studies have shown that reliance on smartphone-based navigation may negatively affect spatial learning and memory by reducing users' active engagement with spatial information (Sugimoto et al., 2021; Gardony et al., 2013; McKinlay, 2016; Ishikawa et al., 2008). Currently, a research gap exists regarding how future primary school teachers perceive and evaluate different cartographic media in educational contexts, how their personal navigation practices shape pedagogical preferences and how they conceptualize the role of paper and digital maps in the development of pupils' cartographic literacy. To address this gap, the present study investigates how future

primary school teachers use maps in everyday contexts, how they perceive the contemporary relevance of paper maps, and which cartographic media they prefer for teaching cartographic literacy in the initial stages of primary education. Furthermore, the study examines whether they recognize the potential educational benefits and limitations associated with the use of modern navigation technologies in primary school instruction.

Background

The reasons why both younger and older school students should know how to use maps are widely known and well explained in the literature. Maps are complex communication tools. They are not only the result of human spatial cognition but also a cognitive tool. Using and thinking about maps may help children acquire abstract concepts of space and the ability to think systematically about spatial relations they have not experienced directly (Uttal, 2000). Map-based activities are important for children's holistic development and are linked to general cognitive abilities and skills, as evidenced by numerous studies (Catling, 2020; Cornell and Heth, 2006; Havelková and Hanus, 2019; Hirsch and Sandberg, 2013; Leplow et al., 2003; Segara et al., 2018; Spencer et al., 1989; Hojnik and Hus, 2012; Uttal, 2000). Many details of the features of mobile mapping, space, cartography, and the digital are collected in a book by Wilmott (2020). Because of these educational benefits, map-reading skills are introduced from the first years of primary education in many countries, usually as part of geography education. At the same time, schools are increasingly expected to develop students' digital competences (Zuljan and Valenčič Zuljan, 2015). However, we have not observed any instances where the ratio of paper to digital/electronic maps is prescribed or recommended. Consequently, teachers face the challenge of selecting learning materials and teaching approaches that foster cartographic literacy, spatial thinking, and digital literacy.

The rapid spread of smartphones has changed the way people use maps in everyday life, and teachers should consider this when planning and implementing the teaching process. In connection with maps, students at different stages of their studies can use technology to advance in various fields of digital literacy application, such as (adapted from Tinmaz et al., 2022) technology (ICT, GIS), networking, information, cultural industries (film, leisure), citizenship, academic issues, education and social issues (teamwork, collaboration), as well as on the personal level (critical, analytical,

innovative thinking). Mobile maps provide numerous advantages, which make digital navigation highly efficient and explain its widespread adoption among younger generations (Sugimoto et al., 2021; Wilmott, 2020).

At the same time, researchers have questioned whether constant reliance on digital navigation influences the development of spatial knowledge. Several studies suggest that GPS-supported navigation may reduce users' active processing of spatial information, resulting in weaker spatial memory and less accurate cognitive maps compared with navigation using paper maps (Ishikawa et al., 2008; Gardony et al., 2013; McKinlay, 2016; Sugimoto et al., 2021). Evidence from cognitive neuroscience supports these findings by showing that different forms of navigation engage different cognitive processes and brain networks associated with egocentric and allocentric spatial representations (Epstein et al., 2017; Pullano and Foti, 2022). Although these findings do not imply that digital maps are educationally inferior, they indicate that different cartographic media (traditional paper or digital/electronic mobile media) may support various aspects of spatial learning. From an educational perspective, these findings suggest that the choice of cartographic media is not merely a matter of convenience or technological preference but may influence the development of spatial thinking and orientation skills in children. Although neuroscience evidence cannot directly determine classroom practice, it provides a theoretical rationale for considering how different cartographic media support different learning processes. This is particularly relevant for primary school teachers, who make instructional decisions about when and how children are introduced to paper and digital maps as tools for developing cartographic literacy.

Despite growing interest in digital navigation and spatial cognition, relatively little is known about how future primary school teachers evaluate different cartographic media for educational purposes. As teachers shape the development of cartographic literacy, their beliefs influence children's spatial thinking and digital competence. Understanding these perspectives can help improve teacher education and support evidence-based instruction in cartographic literacy.

Comparison of the characteristics of paper and electronic/digital mobile maps

To synthesise the characteristics discussed in the literature (Spatialpost, 2021; Cabanatuan, 2007; Reilly, 2003) and based on the author's research and teaching experience, Tables 1, 2 and 3 summarise the most important findings regarding paper and electronic/digital maps used via smartphones in terms of technical and functional characteristics, cognitive, social and user aspects, and environmental and

sustainability aspects. These comparisons provide the conceptual framework for interpreting the empirical findings presented later.

Table 1
Comparison of key features of paper and electronic/digital mobile maps in terms of technical and functional characteristics

Aspect	Paper maps	Mobile maps
Data structure	Static, printed representation, fixed amount of data	Dynamic, digitally stored and processed data, allows data filtering and selection of details
Visualisation	Fixed view and scale	Adjustable view (zoom, layers, 2D/3D)
Spatial overview	Comprehensive large-area overview ('big picture')	Better for smaller areas, clarity decreases when viewing larger areas
Content customisation	Fixed content (limited features) for a specific purpose	Customisable content for different purposes (easily changeable)
Navigation style	User-directed orientation and interpretation	Assisted navigation (GPS, turn-by-turn guidance)
Visibility	Clearly visible in daylight, external light required in low-light conditions	Screen glare in daylight, brightness can be adjusted, good visibility at night
Interactivity	None	Highly interactive
Data processing	No digital processing	Easy digital transfer and processing
Annotation	Limited, manual notes only	Flexible digital annotation and storage
Updates	Static, may become outdated	Real-time updates

A comparison of different cartographic media does not privilege one type over another; instead, it highlights characteristics that may function as strengths or limitations depending on the context. As shown in Table 1, paper maps provide a fixed, comprehensive overview but cannot be updated, whereas mobile maps offer dynamic, customizable, and interactive navigation at the expense of large-scale clarity.

Table 2
Comparison of the characteristics of paper and electronic/digital mobile maps from cognitive, social and user perspectives

Aspect	Paper maps	Mobile maps
Cognitive demand	Higher cognitive effort, promotes spatial reasoning, interpreting the data is challenging	Lower cognitive effort, system-guided navigation, easier interpretation (using satellite images or 3D views)
Skills required	Map literacy (scale, symbols, orientation)	Digital/technical literacy
Social use	Shared use and interaction (e.g. asking for directions, meeting new people)	Mainly individual use (individual approach to problem-solving)
Navigation purpose	Better suited to exploring the wider area and planning routes	Efficient navigation to known destination

Environmental interaction	Encourages stopping and direct observation	May reduce attention to surroundings (missing the beauty of nature)
Emotional/tactile experience	Physical, tactile (touching paper as a natural material), possibly a memento of someone or a precious souvenir	Screen-based (touching plastic as an artificial material), allows emotional attachment through content
Familiarity	'Old-fashioned,' traditional / less familiar to younger users, an "exotic" experience of the past	'Modern,' familiar in everyday life, associated with modern device use and peer identity
Handling	Unfolded maps can be awkward to hold and use (can tear or crease)	Easy one-handed use
Multiple users	Easily shared	Rarely shared
Independence	Promote self-reliance	Dependent on device functionality
Risk of failure	Minimal technical failure	Possible technical issues or frustration, battery, connectivity or software failures
Advertising	Rarely contain advertisements	May include intrusive, non-skippable advertisements
Costs	Affordable for everyone, low cost, no data fees	Device and data costs may increase social inequality
Privacy	No tracking, complete privacy	Location tracking, recording and data storage possible

Paper maps demand traditional literacy and high cognitive effort for wide-area exploration, fostering self-reliance and social interaction without technical risks but in complete privacy, whereas mobile maps minimize navigation effort for known destinations via individual, device-dependent technology that introduces potential privacy, advertising, and financial barriers (Table 2). While paper maps offer energy-independent, signal-free navigation at the cost of weather vulnerability and slower search times, mobile maps provide fast, optimized routing but depend heavily on device power and network connectivity (Table 3). This confirms that the reliability and accessibility of paper maps still represent a significant advantage in certain situations.

Table 3
Comparison of the characteristics of paper and electronic/digital mobile maps from environmental and sustainability perspectives

Aspect	Paper maps	Mobile maps
Energy use	No energy required	Requires charging
Accessibility	Works without signal/internet	Requires connectivity, signal may be limited (in forests or remote locations)
Physical constraints	Weather-sensitive (rain, wind, snow), physical transport required	Device-dependent but portable

Environmental impact	Recyclable paper waste	Complex recycling due to mixed materials
Transport/logistics	Physical distribution required	Route optimisation reduces CO_2 emissions
Time consumption	Slower orientation and location search	Fast, efficient navigation

A review of comparisons between paper and electronic/digital mobile maps shows that neither type of map is universally superior. Although each cartographic medium contributes to cartographic literacy, spatial thinking, and digital competence, the key educational challenge is how to integrate these different media effectively. Understanding the beliefs and preferences of future teachers – the focus of the remainder of this text – can therefore provide valuable insights into teacher education and support evidence-based decisions regarding the use of paper and digital maps in primary school education.

Research design

This study examined how future primary school teachers use and perceive paper and mobile maps. A mixed-method survey design was employed, combining quantitative and qualitative research approaches for data collection and analysis.

Aim and research questions

The aim of the study was to determine which cartographic media university students use today and what they, as future primary school teachers, think about the use of paper and mobile (digital/electronic) maps for developing cartographic literacy among primary school students.

The study addressed the following research questions:

RQ1 Which types of maps do university students (future primary school teachers) prefer to use: paper maps or maps on a mobile navigation app?

RQ2 Do university students believe that paper maps are outdated for outdoor navigation?

RQ3 Which type of map would university students prefer to use when teaching cartographic literacy in primary school, and why?

Participants

The study was conducted among students enrolled in the upper years of the Classroom Teaching programme at the Faculty of Education, University of Ljubljana. Future primary school teachers were selected as the target population because they will soon make decisions regarding the selection and pedagogical use of paper and digital maps in schools. Their beliefs and preferences will therefore likely influence how cartographic literacy and digital competence are promoted in primary school education.

Full-time students in the 3rd, 4th, and 5th years of study were invited to participate in the survey in the spring 2023. Of the 214 students invited, 129 completed the questionnaire, representing 60% of all full-time enrolled students. Participants came from different regions of Slovenia. The response rate (Table 4) was highest among third-year students (86%), followed by fourth-year students (56%) and fifth-year students (40%). Most participants were female, reflecting the gender distribution in the programme; only five male students were enrolled across all three cohorts. All participants owned a smartphone.

Table 4
Enrolled students and completed questionnaires by year of study

Academic year	Number of enrolled students in the academic year	Number of completed questionnaires	% of enrolled students who completed the questionnaire	% of total number of survey participants
3rd year	59	51	86	40
4th year	70	39	56	30
5th year	85	34	40	26
Not specified	-	5	-	4
Total	214	129	60	100

Data collection and analysis

Data were collected through an online questionnaire, hosted on the Slovenian web portal 1ka.arnes.si.

The questionnaire was organised into three thematic sections corresponding to the research questions: everyday paper and mobile map use, the relevance of paper maps for outdoor navigation, and map integration in primary education. Closed-ended questions collected quantitative data on usage patterns and attitudes, while open-ended questions provided qualitative depth.

Participation was voluntary. Students were invited to participate three times at 14-day intervals, with the highest response rate observed following the first invitation. The average time required to complete the questionnaire was approximately three minutes.

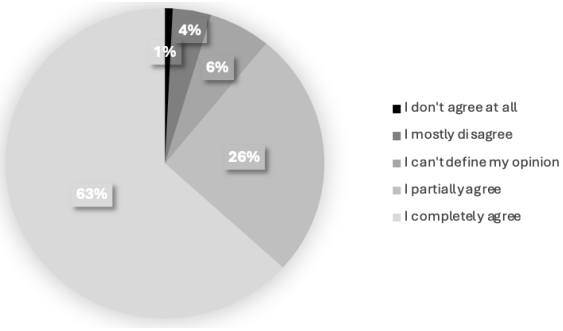
The data were analysed using descriptive statistics and content analysis of the responses with the help of the SPSS statistical software. Quantitative data obtained from closed-ended questions were analysed using descriptive statistics in SPSS, while responses to open-ended questions were qualitatively analysed using content analysis.

Results

Preferences for and use of mobile and paper maps

Students showed a strong preference for mobile maps when navigating outdoors (Figure 1). Nearly two-thirds of the respondents (63%) expressed a clear preference for mobile maps. When students who reported a moderate preference (26%) are included, the proportion rises to 89%. Only 5% of the students preferred paper maps, while 6% were undecided.

Figure 1
Students' agreement with the statement: "In the field, I prefer to use a mobile map (navigation) rather than a paper map."



To better understand students' map-use practices, respondents were also asked about their use of mobile maps during the previous year. All participants reported using mobile maps to find a location, while other common uses included sending coordinates to others (41%), marking locations (27%) and various other activities (9%), such as finding shop opening hours, planning trips, looking for ideas for an outing, exploring places, calculating route lengths and playing games with scouts.

For on-foot navigation in unfamiliar environments, 86% of the students reported primarily using mobile maps on their smartphones during the previous year.
In contrast, only 4% of students primarily used paper maps, while 7% used both cartographic media equally.
Three percent reported not having used maps for on-foot navigation during the previous year. Students also reported frequent use of mobile maps in everyday life. During the seven days preceding the survey, 43% had used a mobile map two to three times, 23% once, 13% four to five times, 9% six to nine times, and 5% more than ten times. Only 7% had not used a mobile map during the previous week. Interestingly, a more balanced pattern emerged when students were asked about the cartographic media they used when preparing for their geography exam at the faculty. Paper maps or printed atlases were used by 31% of the students, electronic/digital maps on a computer by 30%, and maps on a smartphone by 8% of the students. Both cartographic media were used equally by 23%, while 9% of the students reported not using maps when preparing for the exam.

Perceptions of the relevance of paper maps

Students held mixed views regarding the relevance of paper maps for contemporary navigation8 in the field (Figure 2). One third of the respondents (33%) believe that paper maps are partially outdated for outdoor navigation, while 15% regarded them as entirely outdated. Together, these groups indicate that nearly half the surveyed students (48%) considered paper maps to have diminished relevance in outdoor navigation. At the same time, 30% of respondents believed that paper maps remain relevant, while 22% were undecided.

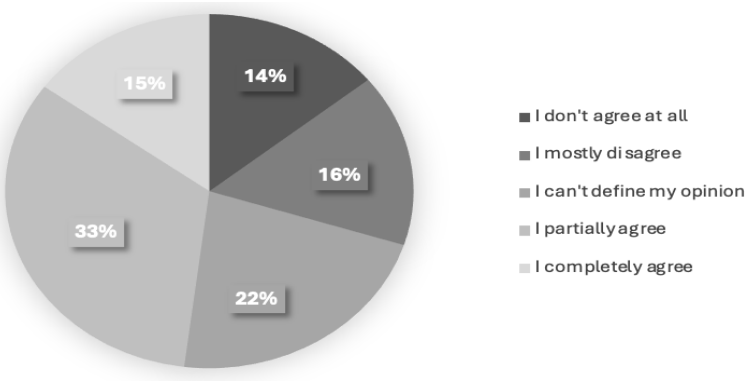


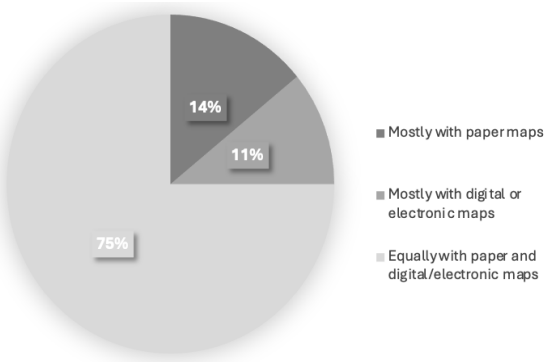
Figure 2
Students' agreement with the statement "Paper maps are outdated for outdoor navigation."

Preferred approaches to teaching cartographic literacy

When asked which type of map the students would prefer to use when teaching cartographic literacy in primary school, three-quarters of respondents selected a combination of paper and digital or electronic maps (Figure 3). Among the remaining quarter of the students, a slightly larger proportion preferred paper maps (14%), while 11% preferred digital or electronic maps.

Figure 3

Students' opinions on the cartographic media they would choose to teach cartographic literacy to primary school students



Among respondents who preferred paper maps, the most frequently cited reason was that paper maps encourage greater cognitive engagement and support children's development. Students argued that working with paper maps requires greater effort, concentration, and independent thinking when orienting oneself in space.

One respondent noted that paper maps "better stimulate children and their development, as they have to put in more effort themselves." Other arguments included reducing children's screen time, ensuring that map-reading skills can be used without technological devices ("they need to learn how to work with paper maps first, since phones aren't always available"), promoting active participation ("students are more active", "students must pay closer attention when working with paper maps"), and maintaining familiarity with a traditional but still useful navigation tool ("paper maps are still useful, and as much as possible, content for students should not be presented via devices"). Several respondents also suggested that learning to use paper maps provides a foundation for understanding digital maps ("if they know how to use paper maps, they'll know how to use digital ones too") and contributes to the development of logical thinking ("it's important for students to hold the map in their hands and use it as a teaching tool that develops logic").

Other participants emphasised the practical value of paper maps, noting that they remain usable when mobile phones are unavailable or out of battery ("they need to learn how to work with paper maps first, since phones aren't always available").
Respondents also perceived paper maps as clearer and easier to understand, suitable for all children regardless of access to technology ("paper maps are clearer;" "every child can work with paper maps at any time;" "they are more useful and easier to understand"). A few participants additionally expressed greater trust in printed information than in digital content ("sometimes we have greater trust in what's written on paper").
The most common reasons among the students who stated they would primarily use a mobile navigator in lessons with school students were that "digital maps are more useful" and that "this way, students are in step with the times." Other respondents emphasised that digital maps reflect the realities of contemporary life and prepare children for the future ("this way of working will be more familiar to today's students when they grow up;" "given societal progress and the popularity of digital or electronic maps, their use makes more sense;" "we all have them on our phones;" "we don't use paper maps anymore"). Practicality was another frequently mentioned advantage, with participants highlighting that digital maps are always available, easier to use in diverse conditions, and continuously updated ("walking with a map in hand is impractical;" "they update faster and are always at hand;" "they're more practical, e.g., in the rain"). Students also appreciated the additional functionalities of digital maps, including interactive features, zooming, measuring distances, and viewing different types of geographic information ("you can view roads or terrain and zoom in;" "you can measure distances;" "mobile maps have added value;" "they offer so many different uses, including interactive ones, that it would be a shame not to take advantage of such a learning tool"). A few responses also reflected the declining familiarity with paper maps ("I don't even know where you buy a paper map"), and the perception that digital maps are clearer and more convenient to use ("they're clearer").
Students who favoured using both paper and digital cartographic media for developing cartographic literacy most frequently (18 responses) emphasised their complementary roles, particularly when digital maps are unavailable because of technical limitations such as dead batteries, poor network coverage, or device failure ("paper maps will be useful to students in situations where digital or electronic maps cannot be used"). The second most common view (12 responses) was that children should learn to use both media and understand the advantages and limitations of

each ("I think it's right for children to learn about both options and the advantages and disadvantages of each"). Many respondents argued that paper maps should provide the foundation for learning, with digital maps introduced later to build on this knowledge ("We would explain the basics using paper maps and build on that with digital or electronic ones"). Others noted that the two media develop different skills and that using both offers broader learning experiences ("Reading a paper map requires different skills and knowledge than reading a digital map;" "More methods = more experiences").

Several participants also stressed the importance of balancing traditional and modern approaches. While recognising that children should learn to use digital maps because technology is part of everyday life, they argued that paper maps remain educationally valuable and that students should not rely solely on technology ("Schools must teach students how to use technology, but despite technological advances, working with paper maps will always remain important;" "Children need to be familiar with both forms of navigation, as technology is not entirely reliable").

Discussion

The survey results indicate that mobile maps have become the dominant means of spatial orientation and navigation among university students. Most participating students reported preferring mobile maps for outdoor navigation and using them frequently in their everyday lives. This finding is consistent with broader processes of digitisation and growing reliance on smartphone-based navigation, which is evident in everyday life. The surveyed students particularly valued the practicality of mobile maps, emphasising their accessibility, frequent updating, and interactive functionalities. At the same time, the findings suggest that the widespread use of mobile maps has not led to the complete abandonment of paper maps. When preparing for a geography exam, the surveyed students reported using paper and digital maps in roughly equal measure. Furthermore, many students highlighted advantages of paper maps, including a clearer overview of larger areas, the possibility of physically handling the map, and greater engagement in the process of orientation. These perceptions are consistent with studies suggesting that reliance on mobile navigation may reduce spatial perception, the ability to memorise routes, and the development of orientation skills (Ishikawa et al., 2008; Gardony et al., 2013; Sugimoto et al., 2021).

Students also expressed mixed views regarding the contemporary relevance of paper maps. Although nearly half the participating students considered paper maps to be at least partially outdated for outdoor navigation, a substantial proportion did not take a clear-cut stance, indicating that the question of the future role of paper maps remains open. Students often recognise that different cartographic media offer different advantages and that their usefulness depends on the context and purpose of use.

A particularly noteworthy finding is the discrepancy between students' personal navigation practices and their pedagogical preferences. Although they mainly use mobile maps in everyday life, most of them preferred combining paper and digital maps when teaching cartographic literacy. This discrepancy between personal practice and pedagogical decision-making suggests that future teachers distinguish between everyday technology use and educationally appropriate instruction. Such findings are consistent with research indicating that teachers' professional beliefs and experiences shape their instructional choices (Konečnik Kotnik and Javornik Krečič, 2011). Future teachers view cartographic literacy as more than technical navigation skills, encompassing the development of spatial thinking, orientation skills, critical evaluation of information and independent problem-solving. Respondents supported this view by emphasising that paper maps require greater mental effort, attention, and independent thinking, thereby fostering cognitive development.

The findings support Collins's (2018) conclusion that no single approach is optimal for developing spatial thinking. Respondents frequently emphasised that paper and digital maps foster different competences and therefore serve different educational purposes. From this perspective, cartographic literacy should be understood as the ability to interpret, evaluate, and use multiple forms of spatial representation. Therefore, when planning lessons on cartographic content, it would be advisable to combine different cartographic media and adapt their use to the lesson objectives and the students' developmental stage. Integrating both formats can enhance learning through comparative and reflective tasks; students might analyse differences between paper-based tourist maps and digital satellite imagery to understand how cartographic representations vary in abstraction and purpose. A sequential approach can also be beneficial, whereby learners first study spatial layouts using paper maps to construct an initial mental model and subsequently use digital maps to verify and refine their understanding, or vice versa when synthesizing digitally collected spatial data into paper-based visual summaries.

Such blended pedagogical designs leverage the strengths of each medium – paper maps for global structure and memory formation, and digital maps for interaction, immediacy, and data-rich exploration – thereby supporting more comprehensive spatial learning outcomes.

The study has several limitations. First, the sample consisted of students from a single faculty and was predominantly female, limiting the generalisability of the findings to other populations of future teachers. Second, the study relied on self-reported behaviours, attitudes, and preferences rather than on objective measures of map-use competence or navigation performance. Third, the study focused on future teachers' attitudes towards and perceptions of cartographic literacy rather than directly assessing their cartographic knowledge or spatial abilities. Further research could therefore include an experimental comparison of orientation performance using different cartographic media and monitoring the impact of individual approaches on the development of spatial thinking in children.

Conclusion

The study showed that future primary school teachers use mobile maps significantly more often than paper maps in their daily lives, primarily because of their practicality, accessibility, and numerous functionalities. Nevertheless, paper maps are not perceived as entirely obsolete.

Instead, they recognised the value of these for understanding space, developing orientation skills, and fostering independent thinking.

A particularly noteworthy finding is that, although future teachers mainly use mobile maps themselves, most would prefer a combination of paper and digital maps when teaching cartographic literacy. The results indicate that future teachers conceptualize different cartographic media as serving distinct functions, with mobile maps being associated primarily with practical everyday navigation and paper maps being perceived as more appropriate for educational applications. This approach, which combines various cartographic media, facilitates the development of diverse types of spatial and digital competences and enables students to gain a more comprehensive understanding of space.

The findings suggest that completely replacing paper maps with digital maps for educational purposes may not be advisable. Instead, when teaching cartographic content, it is important to maintain a balance between traditional and modern approaches and to equip school students with the skills to use different cartographic

media critically, independently, and responsibly. Future developments in cartographic literacy education should therefore focus on the thoughtful integration of digital technologies while preserving opportunities for active spatial thinking and direct experience of space.

Research Data Accessibility Statement

The article is based on the sources listed in the reference section (no archival sources were used).

Statement on the Use of Generative AI Tools

No generative AI tools were used in the preparation of this paper to generate text, data, code, analysis, interpretations, or visual content. All content of the paper is the result of the authors' own scientific and professional work.

Informed Consent Statement

All research participants were adequately informed about the purpose of the study prior to their participation and provided their informed consent to participate.

Conflict of Interest Statement

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