

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The use of digital maps in education has increased significantly over the past ten years. As well as their obvious use in geographical and associated subjects, maps are also used in areas such as history, biology, natural history, social sciences and medical epidemiology, as well as, of course, everyday use for navigating when travelling, or in shopping centres. Given such widespread use learning to read and interpret maps can be considered to be a general life skill. This paper will focus on the use of digital maps in education, and will consider what digital maps can offer above and beyond traditional paper maps and also the issues involved in designing and using digital maps. There are two main aspects to the use of maps in education, both within geography and cognate areas and in other domains where maps are used. These are: teaching students to use maps as resources for information discovery, exploration and illustration and teaching students to be critically aware of how the design of maps influences their communication to the user. The paper will discuss how digital maps have the potential to help both these learning processes.

A digital map can be thought of as a computerised display of geographically referenced information, i.e. data identified according to their locations. In the same way that individual maps contain a wealth of information, and are used in diverse ways by individuals and organisations, digital maps are also used in diverse applications. Applications range from databases of electricity networks to aid maintenance and supply, to displaying the extent of deforestation in the Brazilian Amazon.

Given such diverse applications, digital maps are now used by many institutions including local and national governments, research institutions, businesses and industry. Planning offices might, for example, use digital maps to keep a record of property boundaries; and they could be used in market analysis where it is necessary to know location of customers, the distance they have to travel, the best places to advertise and location of competitors. The wide application area of digital maps requires a number of subject areas to incorporate the teaching of spatial skills and data manipulation into their programmes of study, to assist graduates with career options.

2.2 CONCEPT OF DIGITAL MAPPING

Digital mapping refers to the process of collecting, analyzing, and visualizing spatial data in a digital format. It replaces traditional paper-based cartography with dynamic, interactive, and updatable maps (Kraak & Ormeling, 2020). According to Chang (2019), digital maps integrate layers of information such as terrain, infrastructure, and land use, providing a comprehensive view of a location.

Digital mapping refers to the process of creating, analyzing, and displaying geospatial data in an electronic format. Unlike traditional paper maps, digital maps are dynamic, interactive, and capable of integrating multiple data layers (Longley et al., 2015). The shift from analog to digital cartography began with the advent of computers in the mid-20th century and has since evolved with advancements in satellite technology, GIS, and web-based platforms (Kraak & Ormeling, 2020).

According to Goodchild (2007), digital mapping is a subset of geographic information science (GIScience), which encompasses spatial data collection, storage, analysis, and visualization. The key distinction between traditional and digital mapping lies in its interactivity, real-time updates, and multi-layered data integration (Chang, 2019). Digital mapping, often

referred to as digital cartography, is the process of creating and visualizing maps using digital technologies such as Geographic Information Systems (GIS), remote sensing, and spatial data models. This method allows for the efficient representation of geographic features through digital tools, offering a dynamic alternative to traditional paper maps. Unlike static maps, digital maps are interactive and can be updated in real time, making them valuable for a wide range of applications, including urban planning, environmental monitoring, and navigation. The primary characteristic of digital mapping is its ability to handle geospatial data, which can be either vector-based (points, lines, and polygons) or raster-based (gridded data or imagery), and to use this data to generate maps that accurately represent physical and human-made features of the earth's surface. Geographic Information Systems (GIS) play a central role in digital mapping by enabling users to collect, analyze, and manage spatial data in a digital format, facilitating complex spatial analyses and map creation. Remote sensing, which involves obtaining data about the earth's surface via satellite or aerial imagery, further contributes to the accuracy and detail of digital maps. These technologies have made it possible to monitor large-scale environmental changes, such as deforestation or urban expansion, with greater precision and on a global scale.

Kwan et al., (2003) stated that, one of the significant benefits of digital mapping is its capacity for interactivity. Digital maps often allow users to zoom in, manipulate, and overlay various data layers to gain a deeper understanding of spatial relationships. These interactive features distinguish digital mapping from traditional paper maps, making them particularly useful in sectors such as disaster management, where timely and accurate data is crucial. For example, emergency responders rely on digital maps to visualize the extent of a disaster, identify evacuation routes, and allocate resources effectively. In urban planning, digital mapping enables planners to create detailed city layouts, assess land usage, and model future developments.

Furthermore, with the advent of mobile devices and GPS technology, digital maps have become integral to navigation systems, providing real-time, location-based services that guide users to their destinations with unprecedented accuracy (Zook et al., 2010).

As digital mapping technologies continue to evolve, the integration of advanced tools such as artificial intelligence (AI), big data analytics, and 3D mapping is enhancing the sophistication and applications of digital maps. For instance, AI is being used to predict traffic patterns and optimize route planning, while 3D mapping technologies are creating more immersive visualizations for applications like architecture and urban design (Tao et al., 2011). However, despite its numerous advantages, digital mapping also presents challenges, particularly concerning data accuracy and the digital divide. Inaccurate data collection methods, outdated images, or low-resolution satellite imagery can undermine the reliability of digital maps, while unequal access to the necessary technologies can create disparities in how different regions or populations benefit from these tools (Elwood, 2008). Moreover, privacy concerns have emerged as location-based services and the collection of personal geospatial data become more prevalent (Zook et al., 2004).

In conclusion, digital mapping represents a significant advancement in cartography, offering more flexible, accurate, and interactive maps compared to traditional methods. As the technology continues to progress, it will likely play an even greater role in addressing global challenges, from environmental conservation to disaster response, by providing decision-makers with the tools to visualize and analyze geospatial data in innovative ways.

2.2.1 CORE TECHNOLOGIES IN DIGITAL MAPPING

1. Geographic Information Systems (GIS)

GIS is the backbone of digital mapping, allowing users to capture, store, manipulate, and visualize spatial data. It enables:

- **Spatial analysis** (e.g., proximity assessment, terrain modeling)
- **Data layering** (overlying roads, buildings, and land use)
- **3D modeling** (virtual representations of real-world environments)

As noted by Burrough & McDonnell (2015), GIS integrates **cartography, statistical analysis, and database technology** to support decision-making in urban planning, environmental monitoring, and infrastructure development.

2. Remote Sensing and Aerial Imagery

Remote sensing involves capturing Earth's surface data via satellites, drones, or aircraft (Jensen, 2015). Key applications in digital mapping include:

- **High-resolution satellite imagery** (e.g., Google Earth, Sentinel-2)
- **LiDAR (Light Detection and Ranging)** for 3D terrain modeling.
- **Hyperspectral imaging** for environmental monitoring.

3. Global Positioning System (GPS) and Field Data Collection

GPS technology provides **real-time geolocation data**, essential for ground-truthing and field surveys (Kennedy, 2020). Mobile GIS applications (e.g., ArcGIS Field Maps, QField) allow mappers to collect data on-site and synchronize it with central databases (Haklay & Weber, 2008).

2.2.2 TYPES OF DIGITAL MAPS

1. Static vs. Interactive Maps

- **Static digital maps** (e.g., PDF maps, printed digital outputs) are fixed and non-editable (Kraak & Ormeling, 2020).
- **Interactive web maps** (e.g., Google Maps, OpenStreetMap) allow users to zoom, pan, and query data (Roth et al., 2017).

2. Thematic vs. Reference Maps

- **Thematic maps** display specific data themes (e.g., population density, land use) (Slocum et al., 2009).
- **Reference maps** provide general geographic information (e.g., roads, political boundaries) (Dent et al., 2009).

2.3 APPLICATIONS OF DIGITAL MAPPING IN EDUCATIONAL INSTITUTIONS

Digital mapping has been increasingly adopted in schools and universities for facility management, safety planning, and resource optimization. Studies have shown that digital maps enhance campus navigation, emergency response, and infrastructure development (Abdullahi & Mansor, 2018).

1. **Campus Planning and Management:** Digital maps help in tracking school facilities, classrooms, and recreational spaces, aiding in efficient space utilization (Li & Yeh, 2018).
2. **Emergency Preparedness:** Schools use digital maps to identify evacuation routes and emergency assembly points (Cutter et al., 2015).
3. **Student and Staff Navigation:** Interactive maps assist new students and visitors in locating key areas within the school (Goodchild, 2017).

Digital mapping has proven to be an essential tool in educational institutions, offering diverse applications that significantly enhance both teaching and learning. One of its most prominent uses is in geography and environmental science education. Digital maps allow students to interact with spatial data, providing them with the ability to analyze geographical features and understand complex environmental processes. These maps facilitate the visualization of data sets related to climate patterns, population distribution, and topographical changes, which helps students connect theoretical knowledge to real-world examples (Elwood, 2008). This engagement with spatial data encourages students to develop a deeper understanding of geographical concepts and improves their ability to analyze spatial relationships.

In terms of campus management, digital mapping plays a crucial role in enhancing the efficiency of educational institutions. By providing interactive campus maps, students, faculty, and staff can easily navigate the campus, locating classrooms, buildings, and essential resources such as libraries and cafeterias (Van der Meer, 2012). These maps are particularly beneficial for new students and visitors, offering clear and accessible directions. Educational institutions also use digital maps for spatial planning, optimizing campus resources, and making informed decisions about infrastructure development based on spatial data (Stefanakis et al., 2014).

Digital mapping also proves invaluable for fieldwork and research across various academic disciplines, such as archaeology, geology, and urban studies. By incorporating GPS technology, students can gather and record data in real-time, mapping coordinates and locations while conducting research. Geographic Information Systems (GIS) enable students to process large data sets, facilitating data analysis and interpretation (Muehlenhaus, 2013). This hands-on experience allows students to develop critical research skills and apply theoretical knowledge in practical, real-world contexts. Digital maps not only support fieldwork but also enhance the learning of spatial analysis techniques.

For distance learning and remote education, digital mapping is becoming increasingly important. Virtual learning platforms use maps to create immersive, interactive experiences that allow students to explore different regions and historical sites remotely. This makes learning more engaging and offers opportunities for students to experience areas they may never visit physically (Johnson et al., 2016). Virtual field trips, facilitated by digital mapping, broaden students' learning horizons, enabling them to explore different cultures, environments, and ecosystems, even from a distance.

Moreover, digital mapping fosters collaborative learning within educational settings. By working on mapping projects, students can engage in collaborative research and data analysis, whether it involves mapping historical events, social phenomena, or environmental changes. Collaborative projects encourage teamwork, critical thinking, and problem-solving, essential skills for academic and professional success (Ma & Nickerson, 2006). Instructors can use digital maps as a platform for project-based learning, challenging students to address real-world issues like urban planning, resource management, or climate change, using spatial data to derive solutions.

In conclusion, digital mapping serves as both an educational tool and a platform for fostering creativity and interdisciplinary learning in educational institutions. Its applications not only enhance the understanding of academic content but also develop essential skills such as spatial reasoning, critical thinking, and collaborative problem-solving. As educational institutions continue to integrate digital mapping into curricula, students gain access to innovative learning experiences, preparing them for future challenges in a technology-driven world (Goodchild, 2007).

2.4 CHALLENGES AND FUTURE PROSPECTS OF DIGITAL MAPPING

Digital mapping has revolutionized navigation, urban planning, and geographic information systems (GIS), but it faces several challenges that hinder its full potential. One of the primary challenges is data accuracy and reliability. Digital maps rely on vast amounts of data collected from satellites, sensors, and user-generated inputs, which can sometimes be outdated, incorrect, or inconsistent. Ensuring real-time updates and maintaining high accuracy remains a complex task, especially in rapidly changing environments like urban landscapes or disaster-

prone areas. Additionally, privacy and security concerns pose significant risks, as mapping technologies often require access to sensitive user location data. Unauthorized access, data breaches, or misuse of location-based information can lead to ethical and legal complications.

Another major challenge is infrastructure and technological limitations, particularly in developing regions. Digital mapping depends on high-speed internet connectivity, cloud storage, and advanced computing resources, which are not uniformly available worldwide. In areas with limited digital infrastructure, the effectiveness of mapping services is significantly reduced. Furthermore, integrating diverse data sources, including satellite imagery, GPS signals, and crowdsourced contributions, is a complex task that requires sophisticated algorithms and AI-driven automation. Technical challenges in interoperability between different mapping platforms and software also create barriers to seamless data exchange and standardization.

Despite these challenges, the future prospects of digital mapping are promising, driven by advancements in artificial intelligence, machine learning, and geospatial technologies. AI-powered automation is expected to improve data accuracy by analyzing and predicting changes in landscapes with minimal human intervention. The integration of augmented reality (AR) and virtual reality (VR) in digital mapping will enhance user experiences, making navigation more interactive and immersive. Additionally, the rise of autonomous vehicles and smart cities will heavily depend on high-precision digital maps, encouraging further innovation in mapping technologies. Enhanced satellite capabilities, such as high-resolution imaging and real-time data transmission, will also contribute to more detailed and dynamic mapping solutions.

Moreover, open-source mapping initiatives and collaborative mapping platforms are gaining traction, allowing communities to contribute data and improve mapping accuracy in underserved

regions. Government and private sector collaborations are likely to shape the future of digital mapping, ensuring better regulations, data governance, and ethical considerations. As technology continues to evolve, addressing current limitations will pave the way for more reliable, secure, and accessible digital mapping solutions, ultimately transforming various industries and everyday life.