

Artificial Intelligence and Cartography Education: Some Possibilities

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Abstract:

Recently, the integration of artificial intelligence (AI) in the educational field has sparked interest and doubts in equal measure. This work aims to analyze the potential of applying Generative Artificial Intelligence in the teaching and learning of Cartography, to diversify classes and keep up with new technological trends.

Artificial Intelligence is a field of computer science focused on developing programs to perform tasks that require human intelligence, involving skills such as learning, adapting to new situations, solving presented problems, and identifying patterns, which has had significant advances in the last ten years. Whether in the form of applications, platforms, virtual assistants, or other resources, the insertion of AI not only expands the technological possibilities available to educators and students but also offers new perspectives to enhance the quality and effectiveness of teaching.

In education, three movements of AI utilization are noticeable (Mezzomo, Kawamoto, Wonsik, 2023). The first refers to developing educational resources centered on students, performing various pedagogical functions, such as tutoring a set of skills, assisting in the acquisition of concepts, or supporting metacognitive awareness and regulation. The second movement refers to developing assistance tools for teachers, aiming to solve problems, facilitating evaluative processes, or organizing learning situations centered on a specific theme or relating various knowledge areas. Finally, the third purpose refers to developing tools designed to help educational managers, selecting and organizing data quickly and efficiently for visualization and decision-making. The boundary between these three scenarios is thin and complementary, seeking to optimize the teaching and learning process through the synthesis power that AI presents.

Today, education must provide students with direct contact with digital tools and environments. This includes cartography, which works with geoprocessing software, satellite image capture, electronic devices for data collection, and design tools. In the specific context of Cartography education, using this technology emerges as an innovative solution, contributing to making learning more dynamic and accessible.

Cartography, as a content of Geographic education, is an area that explores and represents the complex relations between society and space, recognized for its conceptual breadth and encompassing phenomena that often present challenges to students. Through traditional approaches, understanding this content can be limited. In the transition process from perceptual space to representative space, Cartography, as a language, allows the identification and interpretation of spatial and temporal connections. Elements such as analogies, comparisons, differentiations, orderings, and extensions become clearer and more accessible for analysis (JORDÃO, 2021).

Almeida e Almeida (2014) highlight that school cartography currently focuses on the communication process with new technologies, especially smartphones and the internet. These technologies have transformed how we create, use, reproduce, and evaluate maps, which are present everywhere, from classrooms to cell phones. In this context, AI emerges as an ally capable of offering multiple resources that facilitate both the exploration and understanding of geographical concepts. Given its recent popularization and rapid development curve, we will condense the main possibilities of using AI in Cartography.

The first possibility is using artificial intelligence (AI) to create interactive, dynamic, and personalized maps. With AI, it is possible to simplify both the creation of themed maps and the analysis of geographical data, making these resources more accessible to teachers and students. This approach can be adapted to the curriculum or specific student interests, using platforms like Google Maps and ArcGIS Online. These systems, which integrate AI resources, allow the analysis of large volumes of data, such as the automated classification of satellite images, facilitating the identification of patterns and the generation of detailed cartographic representations. Examples of tools for creating maps using AI can

be found in software like ChatGPT and DALL-E 3, Leonardo.AI, Adobe Firefly, Photoshop and Gemini, which essentially transform descriptions and commands into detailed and realistic images.

The second possibility we can consider is developing activities with AI linked to active teaching methods, such as Game-Based Learning, Station Rotation, Problem-Based Learning, Flipped Classroom, and Gamification, etc.

To illustrate, we will consider an example of an activity that could relate Game-Based Learning, Cartography, and AI. In this method, games, interactive quizzes, challenges, and simulations using geolocation elements can be developed. With AI, it is possible to adapt the stages to the students' knowledge level, promoting greater engagement in the teaching process. AI plays a fundamental role in analyzing players' performance, adjusting the difficulty and content according to individual needs. A practical example is the GeoGuessr application, which could be enhanced with AI to suggest locations based on specific geographical themes, making the experience even more educational and dynamic. Another experience was conducted by Mezzomo, Kawamoto, and Wonsik (2023). In sum, using Microsoft Bing Creator, students described biome characteristics, including location and altitude from maps. By adding their descriptions to the application, it generated high-quality digital images. This activity developed the ability to describe images and analyze specific details to guide image generator programs; personal connection between the student and what was produced, making classroom work meaningful.

Another possibility integrates AI with augmented reality (AR) applications, allowing the creation of immersive and interactive experiences in cartography education. AR-based tools enable teachers to project 3D maps and landscapes, offering students a deeper and more visual understanding of concepts. For example, projects that combine AI and AR can generate interactive historical maps, where students explore territorial changes over time, connecting cartography to history and the environment, or the Quiver application, which presents a 3D image with interactivity from a printed drawing using a cell phone or tablet.

Image analysis is another area where AI can revolutionize cartography education. Deep learning algorithms allow the identification of geographical patterns in satellite images, such as rivers, forests, and urban areas. In the educational context, these tools can be used to teach students to interpret geographical images and understand environmental changes, such as urban expansion or deforestation. Platforms like Google Earth Engine offer an ideal environment to explore these concepts and enhance practical learning.

Regarding practical implementation, it is crucial to detail how generative AI can be integrated into classroom activities. For instance, in teaching cartographic projections, AI tools could generate interactive and personalized visualizations of distortions across different projection types, enabling students to manipulate parameters and observe the results in real time. Another application would be the automated creation of thematic maps from geographical data provided by students, fostering the analysis and interpretation of spatial information in a more engaging manner.

Finally, we can consider AI-mediated educational data analysis as an aid to teachers. AI systems can monitor students' progress, assess their understanding of concepts such as scale, projection, and map reading, and suggest personalized interventions to improve learning. Adaptive platforms, like Khan Academy, can be customized to include specific cartography content, creating more targeted and effective learning experiences.

These applications illustrate how AI can be used to enrich cartography education, combining technology and innovation to create more engaging and accessible educational experiences. By integrating advanced tools, teachers and students can explore cartography more dynamically, connecting learning to real-world problems and developing future abilities.

However, incorporating AI in Cartography education is not without challenges. Ethical issues, such as student data privacy and the potential to exacerbate educational inequalities, need to be rigorously analyzed: "the implementation of AI in education requires a careful and critical approach, considering not only the benefits but also the associated risks and challenges" (DOMINGOS, 2018, p. 89).

Additionally, the discussion concerning the ethical implications of utilizing AI in cartographic education warrants greater depth. Issues such as algorithmic bias in map generation, the potential technological dependency to the detriment of developing fundamental cartographic skills, and ensuring the privacy of student data when using AI platforms are critical aspects that demand careful analysis. While the work explores various possibilities, a more thorough examination of the landscape of related research could enrich the discussion, identifying gaps and opportunities for future investigations in this field.

The rapid evolution of artificial intelligences, such as the emergence of image generators by commands like ChatGPT and DALL-E 3, has brought various possibilities for developing new tools but also raised ethical concerns. AI-generated maps may contain misleading information, causing confusion or misinterpretations. However, it is important to consider that these tools were not specifically designed for cartography, limiting their effectiveness in map-related tasks. The future of AI in cartography may involve creating more accurate and visually appealing maps,

thanks to rapid advances in AI specifically developed for maps, such as GeoAI, which can facilitate map creation processes and even support human creativity in cartographic design.

It is also worth noting that using AI, called chatbots, in education, although promising, presents some risks that should be considered. One of the main challenges is the possibility of providing incorrect or outdated information, which can compromise learning. Additionally, excessive reliance on chatbots may limit the development of students' critical thinking, as ready-made answers can discourage deeper investigation and may be mistakenly seen as a replacement for teachers/classes, specifically in the case of applications like *Socratic*

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