ADDICTION & SOCIAL MEDIA COMMUNICATION

University of Messina - Journal homepage: https://cab.unime.it/journals/index.php/ASMC/
Addiction & Social Media Communication, 2026, Vol.1, No.1, pag. 54-65

The educational process of transition from perceiving geographical space as a perspective projection – to a metric image of a map

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ABSTRACT

The research problem addressed in this article concerns the transition from a perspective-based perception of geographical space, typical of everyday experience, to its metric representation in the form of a map, which is essential for engineering activities and spatial planning. The study is qualitative and conceptual in nature. No traditional research sample was used; instead, the analysis focuses on cognitive and educational processes, employing methods of theoretical analysis and educational modeling. A two-stage model of transition from a perspective image to a map is proposed: the first stage involves constructing a scaled-down model of geographical space, while the second consists of outlining the contours of objects, leading to the creation of an elementary map representation. The results indicate that this approach supports the development of spatial understanding in metric terms and highlight the importance of cartographic education for effective spatial management and for meeting individual and collective societal needs.

Keywords: geographical space, perspective projection, orthogonal projection, map, perception of geographical space

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Doi: https://doi.org/10.13129/3035-1383/asmc-5458

The perception of geographical space in everyday experience

The geographical space in which people live is most often perceived naturally as an image viewed from a single, specific vantage point, which corresponds to the principles of central (perspective) projection. This means that the visual reality with which an individual engages on a daily basis is not schematic or geometrically ordered, but is dynamic, variable and dependent on the observer's position. From the very earliest years of life, a child experiences this space through the sense of sight, learning intuitively to recognise spatial relationships such as distance, the size of objects, or their relative positioning (Yucel & Cifci, 2025).

This process begins in pre-school age, when a child intensively explores their surroundings and gathers their first perceptual experiences. During this period, a natural need to represent reality also emerges – most often in the form of drawing. This is a spontaneous activity, resulting not from formal instruction in the principles of spatial representation, but from an inner need for expression and the recording of observed phenomena. As cognitive and motor skills develop, particularly in early school age, this ability gradually improves – the child's drawings become more complex, and their depictions of space increasingly organised.

The wealth of perceptual experiences a child has accumulated enables them to create simplified yet meaningful representational images. Although these are not the result of a conscious application of the rules of descriptive geometry, they nevertheless reflect an intuitive understanding of the basic principles of central projection. In children's artworks, characteristic features of perspective can be observed, such as the presence of a vanishing point (though often unconscious and irregular) and the gradual reduction in the size of objects as they recede towards the horizon. Elements closer to the observer are usually depicted as larger and more detailed, whilst those further away are shown as smaller and simplified.

These phenomena demonstrate that, through everyday experiences and observation of the world, a child develops intuitive skills in the organisation of visual space. It can therefore be concluded that the foundations of spatial thinking and an understanding of perspective develop naturally, even before the formal introduction of art or geometry education. In this context, a child's drawing becomes not only a form of artistic expression, but also a valuable source of knowledge about how spatial reality is perceived and interpreted.

These principles are not the result of formal education, but stem from the child's acquired

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experience of perceiving the local environment in this perspective. In the child's drawings, one can discern the principles of perspective geometry: the vanishing point and the diminishing size of objects as they approach the horizon line (Fig. 1).

Figure 1.

This ability to transform three-dimensional geographical space into a two-dimensional pictorial image is one of the most intriguing phenomena of human cognitive and cultural nature. It means that humans are capable not only of perceiving space in all its complexity, but also of mentally reducing it and symbolically representing it on a plane, whilst preserving essential spatial relationships such as proportions, directions and distance relationships. This process requires the integration of many cognitive functions, including visual perception, spatial imagination and the capacity for abstract thought.

This phenomenon is universal and timeless. From the earliest stages of civilisation, humans have attempted to capture the reality around them in the form of drawings and diagrams. This is evidenced, for example, by rock paintings, in which – despite their simplified and symbolic nature – one can discern the first attempts to organise space on a plane and to depict the relationships between the objects represented. In subsequent historical periods, this ability was gradually refined, as evidenced by the increasingly complex forms of spatial representation found in art, cartography and architecture.

Importantly, despite advances in imaging tools and techniques, the fundamental principle of translating three-dimensional reality onto a two-dimensional plane remains unchanged. Both ancient and contemporary representations are based on similar perceptual and cognitive mechanisms. Modern humans, like their ancestors, use an intuitive understanding of space to create drawings, maps or visualisations, even if they are not always aware of the formal rules of perspective or geometry.

This phenomenon can therefore be interpreted as one of humanity's fundamental competencies – the ability to represent the world in a simplified yet cognitively meaningful form. It enables not only communication and the transmission of information about space, but also its analysis, the planning of actions, and creative expression. In this sense, drawing becomes a bridge between the direct experience of reality and its symbolic representation, which has accompanied humanity continuously from the dawn of time to the present day.

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The representation of geographical space in a metric projection as an educational challenge

The common perception of geographical space in a central projection has one drawback: the dimensions of objects on the projection plane are a function of their distance from the observation point. This property means that the resulting image is perceived as a non-metric projection.

Historically, when humans led a nomadic lifestyle, this non-metric relationship to geographical space was not of paramount importance. But when humans settled down and formed communities in the form of villages and towns, the concept of metricity took on particular significance. Humans built their relationship with a chosen part of the Earth's surface, developing this space for the purposes of habitation and obtaining food from crops. Perceiving geographical space as a rectangular projection onto a horizontal, metric reference plane required a certain imagination, which took shape alongside the development of civilisation. Using this second way of perceiving space, human settlements were organised in the form of villages, but above all towns, where a limited space had to accommodate a range of structures serving multiple functions: habitation, defence, the production of goods, trade and the fulfilment of spiritual needs. This characteristic of organising and mapping local geographical space whilst maintaining similarity, in a metric form, played and continues to play a dominant role in the organisation of life in modern civilization.

Representing geographical space in a metric rectangular projection presents an educational challenge: how to move from perceiving geographical space in a central projection to a rectangular projection—which ensures the accuracy of the representation of objects—and then to a map image, reduced to a conventional numerical scale.

This challenge lies in the need to guide the pupil through the process of changing their perception of space: from the natural, everyday view of the world (i.e. the central projection, associated with visual perspective), to the rectangular projection, which is a mathematical representation of space and the basis for map-making (Wojtanowicz, 2014).

Central projection corresponds to what a person perceives from their own viewpoint – nearby objects appear larger, distant ones smaller; lines converge in perspective, and the image of the world depends on the direction of view. This is an intuitive, natural way of perceiving the world, closely tied to everyday experience. Meanwhile, a map – as a cartographic tool – uses a rectangular projection, which ensures the accurate representation of shapes, proportions and distances between

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objects in space.

This transition is neither obvious nor easy, as it requires abstract spatial thinking, the ability to orient oneself within a coordinate system, an understanding of the concept of scale, and the conscious transformation of three-dimensional reality into a two-dimensional representation. It is also crucial to make the pupil aware that a map is not a 'pictorial' image, but a diagram based on mathematical principles, in which every object has its own unambiguous position, defined by coordinates, and is proportionally reduced according to a conventional numerical scale.

In teaching practice, this requires a carefully planned educational process that guides the pupil from observing the real world, through models and indirect representations (for example: metric models of reality, 3D models), to a full understanding of what a rectangular projection is and how a map functions as a tool for describing geographical space. Only such a gradual introduction enables students to use maps consciously and effectively – in both their traditional and digital forms.

Contemporary education faces challenges arising from the dynamic development of technology, particularly in the context of the younger generation's perception and understanding of geographical space (Banaszak, 2017). Today's pupils have almost unlimited access to modern technical tools – smartphones, tablets, computers, as well as navigation apps, digital maps and satellite imagery. This technology allows them to quickly and intuitively assimilate spatial data and use it in their daily lives – both for locating places and for planning routes or analysing their surroundings (Bereźnicka, 2022).

However, this easy access to digital tools can lead to a superficial understanding of how maps work and how space is represented. Users often employ a perspective similar to that found in reality – the so-called perspective projection, which corresponds to the way humans naturally perceive the world. Meanwhile, understanding a map in cartographic terms requires mastering the rectangular projection, that is, representing space in a mathematically ordered, flat manner that allows for the precise determination of position and distance.

To help pupils transition from an intuitive, 'natural' perception of space (perspective projection) to a more abstract and formal way of representing it (rectangular projection), the authors propose the use of a certain intermediate form in the teaching process. This form is a metric model of real reality – a tool that enables space to be represented faithfully, whilst preserving its dimensions, proportions and spatial relationships. Such a model can serve as an educational 'bridge', helping

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pupils to understand the complexity of spatial transformations and the logical foundations of map construction.

The application of a metric model of reality in geography education is therefore becoming not merely a method to support learning, but a necessity in a world where technology can both enhance and impoverish the cognitive process if it is not properly integrated with traditional teaching methods (Szczotka, 2013).

This educational issue is particularly significant in the present day, when the younger generation easily familiarises itself with the achievements of modern technology, including computer technology, and has personal means of accessing map or satellite imagery and of facilitating navigation in the local area.

As mentioned above, the educational process of transitioning between these two ways of perceiving geographical space – from a perspective projection to a rectangular projection – should be based on the use of a certain intermediate form. This form is the metric model of the real world.

The miniaturisation of geographical space as an intermediate state between the real world and the metric representation of a map

From a very young age, children show a natural tendency to represent the reality around them through drawing and building spatial models. They instinctively attempt to depict objects they observe in their immediate surroundings – houses, trees, vehicles, people or animals (Szewczuk, 2013). This takes place both in two-dimensional form (for example, drawings and sketches) and in three-dimensional form, through the construction of models from available materials. Children are very keen to use typical educational and toy tools for this, such as building blocks, miniature wheeled vehicles (e.g. cars, buses) or rail vehicles (e.g. trains, trams), as well as building elements that allow them to create simplified versions of buildings, bridges or other spatial structures. Through such activities, they not only develop manual skills and imagination, but also learn the principles of spatial organisation, proportion and spatial relationships between objects (Piaget, 1952).

This innate tendency to build miniature models of the real world has a wide range of applications in both education and entertainment. In an educational context, it plays a key role in fostering the development of spatial, logical and mathematical thinking. In the realm of entertainment, on the other hand – through construction games or model-making – it becomes a form of creative

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leisure activity which can also inspire a deeper understanding of how the real world works.

Figure 2.

From the perspective of pedagogy and spatial didactics, it is worth consciously harnessing children's natural inclination to model space. This provides an excellent starting point for a later, more advanced understanding of spatial structures, the principles of cartography, spatial geometry and orientation in the field.

To stimulate children's imagination and creativity, models of cities, transport routes and various technical devices are constructed (Fig. 2).

A child's full acceptance of such a miniaturised form of a city – and even a fascination with it – stems from their sense of belonging to a peer group of 'little ones' in relation to the world of adults ('big ones'); they instinctively seek forms of expression suited to their level of development and perception. Miniature models of cities, spaces or infrastructure are more familiar to them, more accessible in terms of cognition and manipulation, whilst at the same time offering the opportunity to recreate structures familiar from everyday life.

It is worth emphasising that this identification with the 'little ones' group does not lead to conflict or distance from adults. On the contrary – when building their 'little world', children often imitate the adult world, replicating familiar patterns, social roles, urban layouts or spatial relationships. In this sense, the miniature form of space is not an alternative to the real world, but a creative reinterpretation of it, adapted to the child's cognitive and emotional capabilities (Ryś, 2020).

Building a 'little town' or another kind of miniature space plays an important role in a child's development. Firstly, it allows the child to come to terms with the complexity of the world by simplifying and scaling it down. Secondly, it enables active engagement with the space – the child does not merely observe, but becomes the creator, organiser and manager of their own environment. This type of activity develops creativity, planning skills, hand-eye coordination, as well as a sense of agency and satisfaction from the activity (Bilewicz-Kuźnia, 2017).

As a result, creating a 'little world' is much more than just play – it is a manifestation of children's need to understand and process reality, to build identity within their age group, and a form

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of learning through creative activity (Bennewicz, 2014). This type of activity should not only be supported but also deliberately utilised in teaching processes, particularly in spatial and geographical education.

The image of a map as a projection of a miniature onto a horizontal reference plane

The miniaturisation of the real world, involving the creation of simplified, spatially reduced models of reality, constitutes the first stage in the educational process of transitioning from the perception of space to its cartographic representation. Building a 'small' geographical space – using models, mock-ups, block layouts or simulated urban layouts – allows children to become familiar with basic spatial relationships, such as location, direction, distance and proportion.

Through miniaturisation, children gain the opportunity to actively and physically engage with space, which develops their capacity for spatial analysis and symbolic thinking. The small world they build and modify thus serves as a starting point for a more abstract way of representing space – namely, the map.

In the teaching approach proposed by the authors, the second stage of this process involves just two steps: tracing the objects, i.e. marking their outlines on a flat surface (such as cardboard or paper), and removing the physical models from the spatial scene. As a result of these two actions, only the outlines of the objects remain on the surface – simplified lines representing the shapes and relative positions of the elements that previously existed in the miniature model (cf. Fig. 3). Such a contour-based representation of space can be regarded as an elementary form of a map which – despite its simplicity – retains the basic features of similarity to the actual spatial arrangement. This is already a mapped space, and not merely a constructed one.

Figure 3:

This two-stage procedure is of great educational significance – it fosters the ability to view the real world from a different perspective than before – from above, and not as a central projection but as a parallel projection onto a horizontal reference plane. This way of perceiving geographical space requires a shift towards a creative way of viewing the real world. A drone image, which is also

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a central projection, can provide some support for this way of viewing space. However, for a small local area, it can, to a certain limited extent, be identified with a parallel projection. This equipment, so highly sought after by young people today, may, apart from its entertainment value, also have certain educational benefits related to this topic.

Conclusion

The concept of the transition from a direct, perspective-based perception of space to its organised, metric representation in the form of a map constitutes not only a significant stage in human cognitive development, but also the foundation for conscious functioning within a geographical environment. This process – encompassing the observation of reality, the creation of models of it, and the gradual transition to abstract representations – reflects the classical pedagogical principles espoused by Jan Amos Komensky (1956). The originator of the principle of visualisation emphasised that true knowledge must stem from sensory experience. “Wisdom is not to be drawn from books, but from the sky, the earth, oaks and beeches” (Komensky, 1956, p. 161) – he wrote, advocating for education based on direct contact with reality, especially that which is closest to the pupil. This eminent educator argued that the process of cognition should begin with the observation and modelling of reality, and only then move on to its abstract representations – which is entirely consistent with the idea of transforming the observed space into a map.

His concept of visual learning, based on the primacy of sensory experience, finds direct application in spatial education, where learning begins with contact with the real environment and then evolves towards its symbolic representation.

A map as a specific form of representing geographical space, serves not only as a cognitive tool, but above all as a practical and organisational one. Its significance extends far beyond an illustrative function – it forms the basis for the rational management of space, enables precise location identification, supports investment planning and ensures spatial order. Thanks to maps, it is possible to respect property boundaries, optimise the use of resources and minimise the risk of errors which, on a social and economic scale, could lead to serious consequences. In this sense, the map becomes one of the key tools of civilisation, determining the development of modern societies.

A lack of map-reading skills or insufficient use of maps, on the other hand, leads to spatial disorganisation – planning chaos, property disputes, inefficient management and threats to human

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safety. Given that the Earth's surface is a limited and non-renewable resource in spatial terms, the need for its rational use takes on particular significance.

For this reason, education in understanding maps as a metric representation of space should be regarded as one of the priorities of general education. It requires the development of spatial imagination, analytical skills and the ability to move from the concrete to the abstract. These skills are universal in nature – they are applicable both in technical and engineering fields and in an individual's everyday life. Ultimately, a map is not merely a representation of space, but a tool for understanding, planning and responsible use of space – both on an individual and a societal level.

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Limitations

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article, or declared.

Funding

The author(s) received/no financial support for the research, authorship, and/or publication of this article.

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