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# Children observe the Digital Earth from above: How they read aerial and satellite images

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**Abstract.** Digital aerial and satellite images depicting the Earth surface are not secret anymore and they are easily available for general public. Publishing of aerial and satellite images provoke the questions how the non-experts or the amateur groups can interpret these images, how they are able to cope with vertical or oblique images, with their colour, missing lettering, etc. The paper presents the results of the research of the above mentioned questions where the respondents were the Czech pupils and student at the age of about eleven, fifteen and nineteen years. These results are aimed at the effective exploitation of aerial and satellite images in teaching, they represent also information for imagery producers and distributors. A non-traditional view on the Earth surface from above using aerial or satellite images is one of the opportunities to discover the beauty of the Earth.

## 1. Introduction

Thanks to servers, web sites and the internet the world of aerial and satellite imagery opened to the public. Both adults and children are confronted with new materials such as aerial or satellite imagery. Unlike maps with which people work for more than one thousand years and develop these skills over generations, working with imagery represents a new experience for mankind. The image is not the same medium as a map, they differ in a number of differences therefore reading of an image differs from reading of a map. Although people just started to acquire experience in working with imagery, the images conquer the world. And as the results of research among children and teenagers indicate, a tempo of growth of popularity of imagery is surprising. The question arose how 11, 15, and 19 years old children and teenagers will cope with various types of images and tasks, how the success of solving similar tasks on image and map will differ, and how children appraise the images. Therefore the research refers to a problem of visual and cartographic literacy as well as development of imagination in age of growing mature. The teachers were asked to subjectively assess the difficulty of image reading for their students and the answers were evaluated.

## 2. Image is not a map

Prior to testing of reading of images and maps it was needed to clarify the basic differences between these materials with respect to their perception. Aerial or satellite image differs from a map depicting the same area in a number of differences affecting the interpretation of a content [1]. The image provides a good overview of the area portrayed from above and it preserves even the details that cannot be depicted in a map. The main reason of this it that it is not generalized. The image depicts the real situation of the terrain up to the limit of a resolution of the photographic camera or a sensor. However, as the image shows all the features with all details, the important objects are not distinguished from those less important and a presence of some of them cannot be discovered at all. The image cannot show the names, spot heights nor the grid lines. A single image cannot provide a proper impression of a terrain relief. To identify the features on an image the interpretation aids must

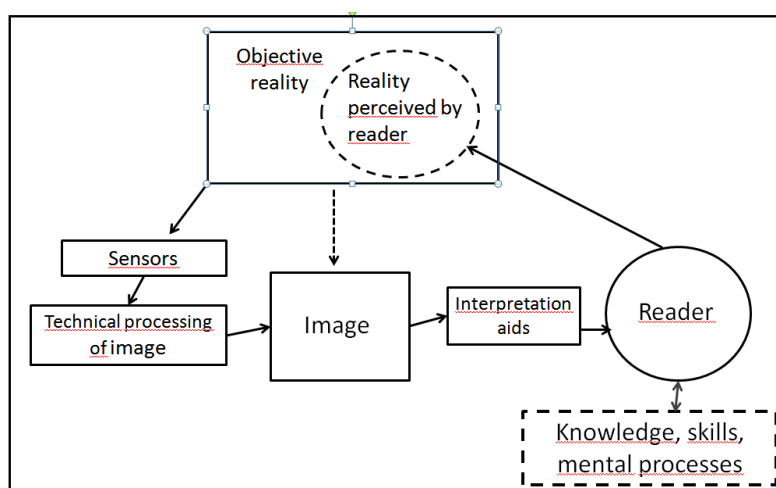
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be used: tone, texture, shadow, pattern, association, shape, size, and site. The image shows the real features whereas the map depicts the features using a cartographic symbology. The interpretation of images is therefore direct without a necessity to work with a legend as the coded source material which is the case of maps. The images can be classified according to various criteria. Considering the research described in this paper the images can be classified according to look angle, colour, and currentness. According to a look angle, the images can be oblique or vertical. According to a colour, there are natural colour images, false colour images, or black and white images. According to currentness, the images can be current or historical. Different types of images place different demands on their readers. Reading vertical images is unusual for the non-expert readers; vertical look without information about the height of the objects, their side walls, or a shape of relief is more difficult than reading an oblique image. The oblique image is more natural for the reader; it brings a better feeling of the depicted area. However, a big disadvantage of oblique images is in deformation of shapes and variable scale. The look angle of vertical images directly affects the use of interpretation aids such as shape, size, site, and shadow. A colour (or a tone) represents another important image interpretation aid. Black and white images generally appear to be more difficult for interpreting. In case of colour images, both natural and false colour, the way of interpretation depends on the aim of the particular task and the need of identification of the features having various physical or chemical properties.

### 3. Image as a model of communication

According to a theory of information technologies, a map and an image can be viewed as the means of communication. Fundamental components of that communication system were presented by Robinson A H and Petchenik B in [2]. MacEachren A in [2] states that the first models of a cartographic communication were introduced in 1967 by Board and in 1969 by Kolacny. Particularly the model of Kolacny inspired us to create the 'image-reader' communication model which is showed in figure 1. The reader creates a mental representation of a reality on the basis of both received information depicted in the image and his or her previous experience. Such representation is identical with a reality to some extent. Unlike map reading where a communication medium of the process is represented by a map, the image misses a subjective view of a cartographer and the use of a coded language. Coding of information on an image can be associated with a colour of the images or with the image classification. The image map can represent a hybrid product where the image contains also a coded language in a form of cartographic symbols, lettering, etc.



**Figure 1.** Model of image reading.

### 4. Reading of images vs. reading of maps

Reading of images and maps belongs to a domain of cartographic and visual literacy. According to the International Visual Literacy Association the term 'visual literacy' can be defined as a skill of receiving and evaluating of visual information using the visual medium. The 'cartographic literacy' comprises reading, using and creating the maps. It can be divided into natural and acquired

cartographic literacy. When working with aerial and satellite images, both the visual and cartographic literacy is needed. Cartographic skills are then a concrete expression of cartographic and visual literacy. When preparing the experiment we built on some theoretical works and research concerning cartographic skills that included reading the maps and, in a broader context, reading the images. The degree of mastering cartographic skills corresponds to the amount of information that we are able to obtain from a map. The skills of working with aerial or satellite images comprise reading the images, analyzing the images, and interpreting the images. Children from three years began to understand the aerial photographs [3] as a representation of the real space, although their understanding continues to develop into adolescence [4]. [1] has proposed a development trajectory for understanding of spatial representation. [5] tested five- and six-year-old American children with vertical black and white aerial photographs and found that children taught about the aerial photographs demonstrated map interpretation ability above untaught peers. [6] asked Puerto Rican five-year-old to interpret vertical aerial photographs centred on the children's school. They concluded that the children had no trouble reading the content of the photographs. [7] tested five- to seven-year-old children using black and white vertical aerial photographs at scales 1:2,000 and 1:3,000 respectively. The children identified the features and then were asked to trace a map on acetate from the photograph identifying the features. They also had to plot a route on their maps. Most children successfully completed the task. These studies concern children before they attend school or in the first years of primary school. In the study described in this paper we present results of comparison of ability to read images with respect to their colour and look angle by adolescent children.

## 5. Research

In the research we focused especially on reading of an image. According to [8], we tested simple tasks on images demonstrating an understanding of spatial arrangement of familiar surroundings. To prepare the solution of the research, the research questions were formulated, the working materials and tests were prepared, and assessment of respondents' answers was compiled.

The research was concerned with evaluating and comparing of cartographic and visual skills in relation to the image, map, or a certain image type. The goal was to compare the interpretation of images with each other and the interpretation of images and maps. Reading the images and reading the maps were assessed as parts of cartographic and visual skills.

### 5.1. Research questions

There was an interest what is the role of the image colour in the image interpretation; how the respondents would cope with the tasks on the old black and white aerial photographs depicting known places such as surroundings of the school; and whether the objects having distinctive shapes would be identified more easily by respondents. It was also examined how the respondents subjectively assess different types of images and whether they prefer maps to images. Six research questions were prepared: 1. Is the identification of objects on a map more successful than their identification on an image? 2. Is the orientation using a map more successful than using an image? 3. Is the success rate of interpretation of objects on the natural colour image higher than on the false colour image? 4. Is a number of identified objects on an image higher than a number of identified objects on a map? 5. Is the interpretation of a historical black and white image more successful using a support of a current image or a map? 6. Considering the user's subjective assessment of the amount of information, is a map better appraised than an image?

### 5.2. Preparation of the test

The test sets containing the tasks considering using images and maps were prepared. The web map portals, the Google Earth, and the Landsat imagery serves were used as the source of images and maps. The maps and images depicting surroundings of the respondents' schools or towns were prepared. These were the following: topographic map in colour depicting surroundings of a school; natural colour aerial photograph covering the same area; natural colour satellite image depicted a particular town; the same satellite image in false colours (i.e. Landsat, RGB 432); image subsets depicting the individual features (e.g. lake, watercourse, fields, forests); subsets of maps; sixty years old historical black and white photograph depicting surroundings of a school; examples of vertical

and oblique photographs; examples of natural colour and false colour photographs; topographic and touristic maps; and a black and white photograph. Materials were divided into the two groups to create two sets of comparable tests. The tests comprised of 11 tasks. Six tasks were objective: 1. Identify the objects highlighted on an image and on a map. 2. Draw the shortest route from a bus stop to the school. 3. Determine the type of an object (lake, river, forest, field, settlement) on a natural colour and false colour images. 4. Match the map subset to a corresponding place on a natural colour and false colour images. 5. List objects depicted on an image and on a map. 6. Draw a school outline to the historical photograph and indicate what existed at that place 60 years ago. Other five tasks were subjective: 1. Is working with images interesting? 2. Do I look at the images on the internet? 3. Do I work with images at school? 4. Mark images and maps according to their usefulness. 5. What do I prefer - images or maps?

### 5.3. Respondents

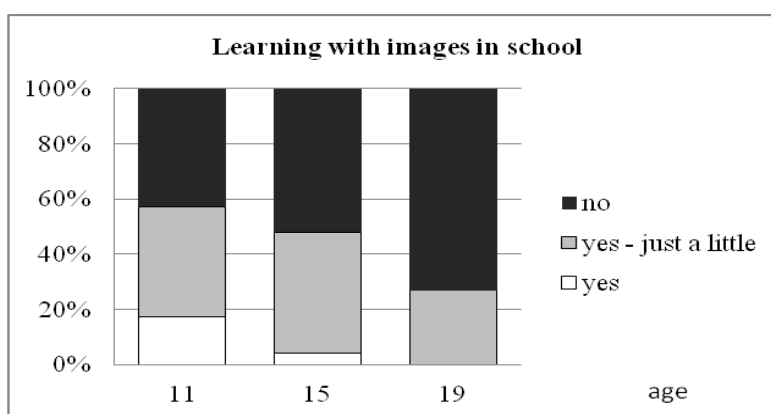
The test persons were pupils and students at age of 11, 15, and 19 years. A total of 92 respondents participated in testing - 50 men and 42 women (see table 1). Children at age of 11 and 15 years were the pupils of primary school in Brno (400,000 inhabitants) in the Czech Republic, the 19 year-old students were the students of the first year at the Masaryk University Faculty of Education in Brno.

**Table 1.** Respondents of the research.

Age	Number	School
11	35	primary 6 <sup>th</sup> year
15	25	primary 9 <sup>th</sup> year
19	19	university 1 <sup>st</sup> year

## 6. Results and conclusion

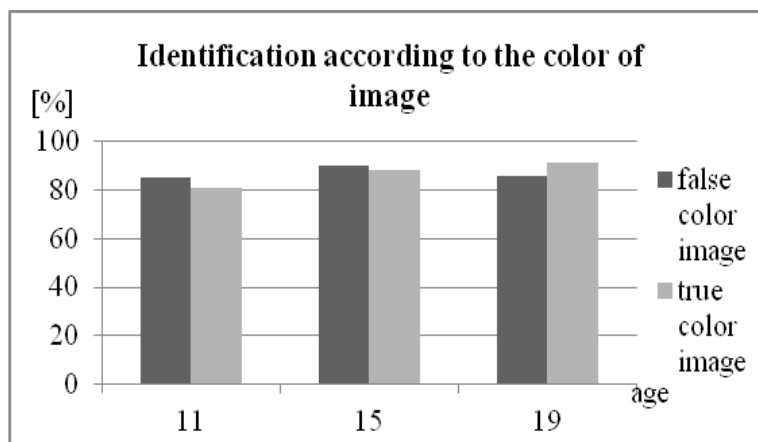
Young people discover the world of aerial and satellite images, even at school. These images recently appeared in school as the new innovative tool. Surveys indicate a rapidly increasing popularity of images among children. The youngest of tested pupils prefer images to maps, almost all of them consider working with images very interesting and amusing. It can be seen the trend of a beginning systematic work with images in school. The group of 11 year-old pupils work with images in school considerably more often than eight years older students who did not experience a regular work with images at all, see figure 2.



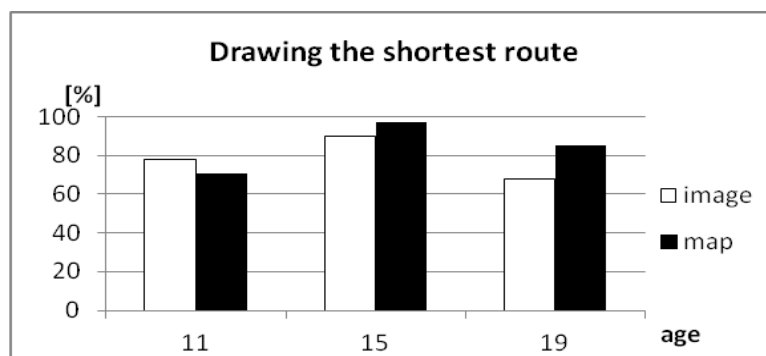
**Figure 2.** Teaching with images in primary and secondary schools.

Apparently, the young teachers prefer using images and they are more optimistic in their estimates of a success of their pupils in working with images. Natural colour image is subjectively appraised by children as the best material with respect to reading and identification of features. Although pupils and students (as well as their teachers) think that reading and interpreting a natural colour image is relatively easy, the results of the research indicate that interpreting false colour images is almost

equally successful or even more successful, see figure 3. The map proved to be the most suitable for orientation during drawing the routes for older students, see figure 4.



**Figure 3.** Success rate of identification of objects on a natural colour image and false colour image.



**Figure 4.** Drawing the shortest route to school on an image or a map.

Maps are considered as much needed by youngest children and very useful by 15 and 19 year-old students. The research indicated possible new trends and it will continue with other test groups composed of older students as well as senior respondents - both non-experts and people working with images and maps as professionals.

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