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## Evaluation of selected maps used in early school education in Poland and proposal of a new solution

**Abstract.** The author presents criteria of evaluation and assumption for early school education maps. Attention was payed to needs and perceptual possibilities of map users and cartographic correctness of maps. Main criteria of map evaluation – content and form of a map – have their unique attributes. In case of the first criterion they are accuracy and currency, classification of content and usability. Second criterion consist of: composition, colours, labels on the map and readability. Materials commissioned by Ministry of National Education were evaluated on the said criteria basis. Evaluation of maps for early school education revealed their flaws, among which absence of a scale can be named. Afterwards assumptions were developed and used to prepare own proposal of a map. Achieving maximum readability was a priority. Other assumptions concerned graphic balance, classification and hierarchy of content, simplicity of elaboration, usage of readable typefaces and adjustment of transmission to the age of users.

**Keywords:** school cartography, map evaluation, spatial thinking, elementary school, image map, map of Poland

### 1. Characteristics of map users

In scientific literature there is a lack of criteria for evaluation of maps dedicated for children at the early school age (grades 1–3 of elementary school). Neither is there a precise, collected set of guidelines and requirements for such maps from cartographic, psychological and methodological points of view. The issues of school cartography are usually related to pupils since the second stage of education (grades 4–8), although map as a didactic tool is applied earlier. In literature in the field of psychology and methodology there are suggestions to use maps in teaching as early as from the age of five (D. Boardman 1990; N.S. Newcombe, A. Frick 2010).

N.S. Newcombe and A. Frick (2010) point out that teachers and psychologists should concentrate not only on developing in pupils such skills as reading, writing or counting, but also on shaping the so-called spatial thinking. A map can stimulate development of this skill. Importance of spatial thinking is also stressed

because of its close links to later results in natural and mathematical sciences, which have been shown in research (N.S. Newcombe, A. Frick 2010; M. Hegarty 2014). It is worth noticing that observed differences in orientation ability in adults of different sexes appear as early as from around the age of eight (D. Boardman 1990). All the more, earlier use of maps in education of children should be promoted, as well as regular use of them in the process of learning.

The main form of children activity is play. Because of that it is important to introduce elements of play into education – learning in a more attractive way. Creating didactic tools appropriate for a given age group requires an understanding of psychological aspects characteristic for the particular group. It would be wrong to directly apply the guidelines used for elaborating maps for adults to maps dedicated for children. Pupils at the early school age are not typical map users, therefore didactic tools should be adapted to their capabilities and needs.

Using a map at such age can help children to develop positive habits and skills, as well as

positively influence the didactic process at subsequent stages of learning. Using maps as early as at the beginning of the first educational stage will make it easier for children to work with them in the next years of learning. It results directly from the Cognitive Load Theory, which in the context of cartography was discussed by, among others, R.L. Bunch and R.E. Lloyd (2006). Cognitive load is the amount of work necessary to receive and use information. Schemes which we assimilate in the learning process remain in our long-term memory. In the case of a map its convention, as well as geographical knowledge (location of towns, etc.) can be such schemes. Thanks to the experience gained before, at the next contact with a map more attention can be paid to new information, and less on what is already known.

## 2. The evaluation of maps for children at the early school age

Establishment of the criteria of evaluation and guidelines for maps dedicated for children at the early school age is necessary in order to develop new cartographical solutions. The Educational Law bill which comes into force on 1 September 2017 changes the core curriculum, which results in changes in curricula and handbooks. Therefore the time seems to be right to evaluate the maps used so far and to introduce new cartographic solutions. For that reason the author analyzes maps of Poland included in educational materials up to 2017. They are two versions of the map from *Nasz elementarz* handbook (M. Lorek, L. Wollman 2014), as well as one map from the handbook for the second grade (M. Lorek, M. Zatorska 2015) and one from the handbook for the third grade (M. Lorek, M. Zatorska 2016). The analysis of these maps aims to evaluate their cartographic correctness and their usability for working with children. The analysis resulted in a critical assessment and conclusions which will be used to prepare guidelines for developing own maps.

According to K. Kałamucki (1998a, p. 4) a complex analysis of a map is "a multilateral examination of elements and features of a cartographic presentation, explaining its specific features and quality, and determining its level of usefulness for solving practical tasks". In the quoted definition the practical aspect of cartography is prominent. Esthetic value is assigned

lesser significance. Selection of criteria is considered by K. Kałamucki (1998a) to be the most important stage of a map evaluation. The criteria of evaluation should fit the purpose and be explained in detail, so that various individuals applying them would arrive at comparable results. Many various sets of map evaluation criteria can be found in literature (K. Kałamucki 1998b). There are as many views as there are cartographers commenting on the subject.

Two main types of criteria concerning map contents and form were selected, with features attributed to them (table 1). Introduction of criteria hierarchy facilitates evaluation. The selection of criteria was performed from the cartographic, psychological and methodological points of view.

Table 1. Criteria of map evaluation

Criteria	Features	
Contents	Accuracy and remaining up-to-date	
	Classification of contents	
	Usability	Range of contents
Compliance with the requirements of the core curriculum and teaching programs		
Form	Composition	
	Colours	
	Labels	
	Readability	Distinction of signs
		Visual clarity

Source: own materials

The criterion of map contents includes three features. The first – accuracy and topicality refers to the level of conformity to reality and precision of objects location accounting for the scale and purpose of the map. The second – proper contents classification refers to grouping and ordering of presented objects. It is strongly linked to their presentation form. The last feature was defined as map usability. It combines the contents range and compliance with the requirements of the core curriculum and teaching programs. The level of usability rises

with the level of consistency of components of particular features. In his analysis of map usability W. Ostrowski (1974) pointed out the importance of subordination of map contents to its purpose.

In the case of school maps the didactic purpose is predominant. W. Ostrowski (1974, p. 15) notes that they should be „especially adjusted to psychological foundations of intellectual activity and education as well as perception of visual impressions”. Because of that map form is the second criterion of evaluation. It consists, among others, of composition, which refers to the graphic balance of map components. It is important that the person editing the map remembers it, especially in the case of users at such young age. A graphic dominant, that is an element which stands out from the map picture, should attract user’s attention. According to the Cognitive Load Theory it is called an Extraneous Cognitive Load. In the case of a map it can also be the text which accompanies it (R.L. Bunch, R.E. Lloyd 2006). Such method should be consciously applied to objects which we want to distinguish. Adults, being more conscious users, may have less difficulty in proper reading of such map.

In the evaluation of map form used colours are also analyzed. They should facilitate the intuitive understanding of map contents. Labels on maps are also evaluated. Important aspects include typeface, clarity, color, size and name placement. In the case of simple texts dedicated for adults fonts in sizes 9–11 are most often used, while minimum font size on a map is 6 points. Lettering for children learning to read should be adapted to their perception ability. A. Wolański (2008) recommends typefaces in which letters are easiest to distinguish. Proper size is considered to be 18 to 20 points. Referring this to maps one can assume that the minimum font size is 9 points. A. Wolański (2008) suggests that in the case of a text dedicated for children who are learning to read slab serif typefaces are used, for they make reading long captions easier. However, this does not apply to maps for children, where mainly simple sans serif typefaces should be used (W. Ostrowski, P. Kowalski 2004).

What is key for map perception is a proper classification of contents and good readability of the map. Readability relies on visual clarity of signs and their accessibility to be distinguished.

W. Grygorenko (1973, p. 59) defines the level of map readability as the “level of difficulty in obtaining and comprehending information about objects and field phenomena on the basis of a cartographic image of the terrain”. In his opinion readability relies mainly on its visual clarity, understood as the ease of obtaining general information about objects basing on the distribution of signs and on how intuitive they are, as well as on their number. In order to facilitate map reading he recommends using generally applied signs and, if possible, a unification of them. While evaluating readability one should consider capability of the user (W. Ostrowski 1974, W. Żyszkowska 1993). On maps dedicated for less experienced users one should strive to simplify the method of conveying information.

### 3. Evaluation of selected maps of Poland used in early school education

*Nasz elementarz* (M. Lorek, L. Wollman 2014) was the main handbook for the first grade since 2014. Beginning in 2016 it started being withdrawn from schools (A. Wittenberg 2017). It contains a map of the Republic of Poland (fig. 1). Initially it was designed as a picture map (fig. 2). After criticism from methodologists of early school education and the media a new version of the map was elaborated basing on the weather map included in the handbook. The criticism concerned the selection and method of contents presentation (A. Ponikiewska 2014, K. Tatarzyńska 2014), among others that more captions refer to the neighboring countries than to Poland and that river names are poorly visible. Vignettes were also considered a weakness. The overabundance of them was pointed out, as well as lack of reference to Polish history of some of them. The authors were also blamed for ignoring the perception ability of 6–7 year olds.

The original version of the map from *Nasz elementarz* (fig. 2) has little contents, and in the middle of the map there is a figure which focuses the attention of the user. The border of Poland is not generalized properly, and even distorted, with incorrectly drawn coastline range (yellow sand) and presenting the region of the Tatra Mts. as completely flat. Composition is also a weakness. The overabundance of dominant graphics makes it difficult to read the main contents of the map. The geographic contents



Fig. 1. The map of the Republic of Poland from *Nasz elementarz* (reduced, source: M. Lorek, L. Wollman, 2014)

are hidden under colorful vignettes. Some of them refer to cities which they are associated with, other refer to natural objects. Regrettably, with the exception of Warsaw they are not named.

Colors play an important role on the map. Their selection can be described as “mild”, except for the coast with a big patch of yellow contrasting with the blue of the sea.

A single decorative typeface was used for names on the map. Sometimes it is difficult to read. Names of the countries neighboring Poland require horizontal placement, because children find it difficult to read vertical text. Thus a larger part of those countries should be presented.

River names are in white, which is another weakness, because they are poorly readable on pale green background. Perhaps they were

based on the map from M. Falski’s *Elementarz* (2003), where river names are visible better, because they are placed against a dark blue background (fig. 3).

Simplicity was the dominant idea during the elaboration of the map which was finally printed in the handbook (fig. 1). It can even be argued that to a certain extent it refers to Eugeniusz Romer’s notion of a “seemingly empty map” (W. Żyszkowska 1993). However it should be noted, that little generalized river network does not support such an opinion.

The range of contents of the final map is much wider than that of the original. All the voivodship cities are marked, there are also more rivers. To amplify the contents concerning Poland the lens effect is applied (less colour saturation outside of the borders). Together with the impression of a “seemingly empty map” it



Fig. 2. The original version of the map of the Republic of Poland from *Nasz elementarz* (reduced, source: <http://lodz.wyborcza.pl/>)

gives the composition a sense of harmony. City symbols and thick solid line used for national borders are the strongest graphic elements.

Colours used on the map are pastel, except for the orange used for city symbols. A weak point is that narrow colour scale is used to illustrate terrain relief. Uplands and mountains are shown in similar shades of yellow, which may suggest that they are similar areas, while hill shading only slightly improves the situation. As a result, terrain relief is not very clear, especially since there is no legend attached to the map. D. Boardman (1990) points out that even children at the age of fourteen and older may have difficulty in interpreting terrain relief. Therefore more attention should be paid to visual clarity of maps dedicated for younger children.

Placing country names neighboring with Poland in curved line makes it difficult for children

to read them. It would be better if they were placed horizontally, just like city names. It would have been possible if more territory of neighboring countries had been presented in the West and East.

Despite the shortcomings presented above, the general level of distinction of the elements of contents on the map can be evaluated as good.

Maps included in the handbooks for the second grade (M. Lorek, M. Zatorska 2015) (fig. 4) and third grade (M. Lorek, M. Zatorska 2016) (fig. 5) are similar to those from *Nasz elementarz*. Better generalization of lakes and more pronounced coastline should be noted. Application of a more developed colour scale and more intense shading for land relief improves visual clarity of the map. Additionally, relief is not limited to the borders of Poland, but covers the whole area presented on the map. The



Fig. 3. The map of Poland from *Elementarz* (reduced, source: M. Falski, 2003)

attached legend is another advantage of the map for the second grade. Unfortunately, its design is incorrect, because natural objects are mixed with anthropogenic ones. National parks are marked on the “island” map for the third grade (fig. 5).

It is easy to notice that all the maps mentioned (figs. 1, 2, 4 and 5) were elaborated by graphic artists, without cartographers contribution. It is visible in the lack of scale, classification and the hierarchy of contents on the map (fig. 2). Some of the mistakes present on the map for the first grade were corrected on the maps for the second and third grades.

#### 4. Guidelines for a map for early school education

Analysis of the earlier maps makes it possible to draw conclusions which can be used in developing a new one. While discussing guidelines it is difficult not to refer to the theory of cartography and to the practice of school cartography.

One of the most important aspects of map preparation is preserving the graphic balance, which also means removing objects which un-

necessarily attract attention. Adaptation of the map to pupil's age should not consist only in the adding of colourful pictures of decorative character. Often they not only fail to achieve their goal, but also, by attracting attention, distract the user from the main contents. Thus they distort the hierarchy of map contents, creating Extraneous Cognitive Load, which was mentioned earlier (R.L. Bunch, R.E. Lloyd 2006).

The choice of colours is also important for the graphic balance. Background colours should be toned down, yet visually clear, which means that they should be intuitively associated with the contents they present. It is also advisable to consider extra-visual attributes of colour (A. Makowski 1979). They are connected to the associations they bring and to the emotional relation with them. Colours can be assigned different attributes, depending on the context. Usage of blue (waters) and yellow (dry areas) are examples here.

Clear location of objects is another important issue. Apart from accuracy also clarity of symbols representing them is important. Rivers, which should be presented with the lines of proper width to guarantee their sufficient visibility, are a specific example.



Fig. 4. The map of Poland from *Nasza szkoła* (reduced, source: M. Lorek, M. Zatorska, 2015)

Proper hierarchy of contents is one of the basic requirements of every map design. In the case of the discussed map, it is the contents referring to Poland, and not to the neighboring countries, that should visually dominate the map. This requirement also refers to point and area symbols and labels. There are many ways of showing differences between them, such as using properly varied symbol sizes, different colours and sizes and boldness of fonts.

Using clear typefaces is another recommendation concerning the use of lettering on maps. For some pupils it is the beginning of process of learning to read, so the used typefaces should be uncomplicated. Also, labels should be horizontal, because those placed along curved li-

nes often require that the map is turned round before a child can read them.

W. Żyszkowska (1993) in her analysis of the idea of map complexity states that simplicity is the main source of success in the process of map reading. The more simultaneous stimuli there are, the more difficult and time-consuming it is to read the map. It becomes easier with proper classification and hierarchy of contents. The speed of perception of the elements of contents depends on their surroundings. It is influenced by the background, contrast and sign density. It is especially important at the first stage of education, when a pupil often has the very first contact with a map.

A requirement of a “seemingly empty map”, earlier promoted by E. Romer, is still prevailing

in school cartography (W. Żyszkowska 1993). According to this idea school maps should be simplified as much as possible, which results from weak map reading skills in the first years of education. The map should be adapted to the perceptual abilities of children. Its complexity affects not only the time needed for a pupil to read the contents, but also the process of memorizing the perceived information.

Multitude of map elements and the fact that a map works simultaneously through picture and text increases the difficulty of reading it. W. Żyszkowska (1993) points out crucial significance of relations between cartographic signs (syntactic relations) and between the signs and their meaning (semantic relations). She lists generalization, cartographic presentation methods and variety of location of the presented phenomena as the factors which influence map readability.

Because of the perception capability of pupils at the early school stage of education it is not advisable to use complex cartographic presentation methods. This means using visually clear symbols and methods of presenting land relief. Limited perception capability of pupils makes it difficult for them to use a hypsometric map

with an attached legend. If map is not visually clear enough to enable intuitive reading of land relief, it is better to abandon presenting it altogether.

Illustrations and vignettes are quite often placed on maps, which makes them seem more visually attractive, but which does not necessarily translate into their actual educational value. The negative impact of using vignettes was criticized in the analysis of the original version of the map from *Nasz elementarz* (fig. 2). However, it should be noted, that placement of images closely related to the contents broadens the range of conveyed information. The map from M. Falski's *Elementarz* (2003) (fig. 3), where clear vignettes of landmark buildings are placed next to the city symbols, is a good example. In consideration of future application of such positive templates, such vignettes have been designed for selected cities.

## 5. Proposal of a map for early school education

Referring to the convention of a pictorial map, a map of landmark buildings presented with vignettes symbolizing cultural landscape was elaborated. Vignettes of buildings were placed



Fig. 5. The map of Poland from *Nasza szkoła* (reduced, source: M. Lorek, M. Zatorska, 2016)





Fig. 6. The map of Poland – vignettes (own elaboration)

by more than half the cities on the map, all of them were also described in the legend (fig. 6).

Linear signs on school maps are as a rule wider than those on maps dedicated for adult users. In the case of the map for the first grade of elementary school a significant thickening of river lines is conventional. A similar approach was adopted on the map of Poland in M. Falski's handbook (2003) (fig. 3).

Typeface, size and colour of the lettering strongly affects readability and the esthetic

value of maps (J. Korycka-Skorupa, P. Kowalski, W. Ostrowski 2010). Elaboration of a simple map dedicated for early school education requires the usage of a limited number of typefaces. Sans serif typefaces are sufficient to achieve good readability and clarity. It is accepted that font size should not be smaller than 9 points.

It was decided to present also the geographical neighborhood of Poland. Contrary to the maps discussed earlier, the area of the

countries neighboring Poland is quite large (fig. 6). Because of that their names can be placed horizontally. The map was elaborated for a school handbook in A4 format in an adjusted scale of 1:6,000,000. However the scale was not shown in figures, but in the form of a bar scale, which prevents quoting wrong scale in the case of size changes.

The basic contents includes: 18 cities, 6 rivers, the Baltic Sea, national borders and names of countries neighboring Poland. National borders are marked with a solid line, and the borders of Poland additionally with a semi-transparent ribbon. Names of the neighboring countries are shown in majuscule. The *Krajobrazowa Mapa Polski* (Landscape Map of Poland) obtained by WMS from the Geoportal 2 (<http://www.geoportal.gov.pl/>) served as the base for the map. The range of contents was selected to avoid map overload and to preserve readability and visual balance.

## 6. Conclusion

Preparing a map for children from the first grade of elementary school was a difficult task. From all the guidelines mentioned in the article, readability of the map was selected as the main one. This study obviously does not exhaust the topic, so a continued research on the issue of elaboration of maps for early school education is needed. There is a lack of comprehensive studies on the perception of maps by children of various age and on parametric criteria of school map evaluation. The three main indicators of evaluation of such maps should be: the perception ability and needs of children, the requirements of core curriculum and the rules

of map edition. It should be noted that adaptation of maps to the perception of children is very difficult, even more so because it is impossible in relation to all students, for their psychological development does not occur at the same pace.

Child's work with a map from the early age can positively influence the skill to use this didactic tool at the future educational stages, and for individuals with dominating visual intelligence, it can also facilitate the process of learning. Additionally, at this stage child's personality is being shaped, so it is worthwhile to interest pupils in the possibility of getting to know the world by using maps. Contact with maps also helps in the development of spatial orientation, and higher skill level in this respect translates into higher chance of getting good results in scientific subjects (D. Schmeinck, A. Thurston 2007; N.S. Newcombe, A. Frick 2010). It would also be advisable to level differences appearing between sexes (D. Boardman 1990), which would require more focus on regular training of spatial thinking.

Finally, it should be stressed that elaboration of maps for early school education ought to be particularly well thought over and especially meticulous in order to make sure that the skills and habits it develops in children are brought to fruition in the future.

## Additional information

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## Maps

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