VILNIUS UNIVERSITY

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PROBLEM OF STANDARDISATION OF THE SYSTEMS OF CARTOGRAPHIC SIGNS
(CASE STUDY OF LITHUANIA EDUCATIONAL GEOGRAPHY AND HISTORY ATLASES)

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VILNIAUS UNIVERSITETAS

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KARTOGRAFINIŲ ŽENKLŲ SISTEMŲ STANDARTIZACIJOS PROBLEMA
(LIETUVOS GEOGRAFINIŲ IR ISTORINIŲ EDUKACINIŲ ATLASŲ PAVYZDŽIU)

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INTRODUCTION

Research problem and the relevance of the study

Various cartographic production including maps have been since long ago used as a means of accumulation, storage and communication of information. The first cartographic products (cave painting) hardly resemble the modern ones yet their destination was the same as today – to convey information. Thus we can positively state that maps have especially old communicative traditions; they are even older than script. For modern people, cartographic production is of special importance and value. Using special symbols, maps encode huge amounts of different information which is indispensible in the everyday life. Thus decoding, perception and assimilation of cartographic images require knowledge of cartographic language which is often regarded as the forth language after the oral and written languages and the language of numbers. It is especially important to learn cartographic literacy already at school. Cartographic literacy and further use of cartographic language and largely depend on the quality of educational cartographic production. Thus the information in the school cartographic production should be conveyed in easily perceptible and memorisable language of cartographic signs.

The students of Lithuania have a good choice of cartographic production yet there are some doubts as to its quality. Cartographic products no always are produced by sufficiently experienced and competent cartographers. Moreover, modern technologies also bring certain confusion as their possibilities are huge and they are constantly up-graded. Perhaps due to this circumstance, even the cartographers of highest qualification in their aspirations to create something new, attractive and unseen deviate from the elementary cartographic rules and principles. These problems could be solved by partial standardisation (otherwise referred to as unification, equalization or regulation) of school cartographic production. Often even the same authors and publishers in their different products use different cartographic symbols for the same objects, phenomena and processes what encumbers the process of reading, perception and memorization of symbols. For this reason, every time when trying to read a map, students are forced to use the legend in order to decode the information.

Standardisation of the system of cartographic signs used in the maps of school geography and history atlases is neglected both in Lithuania and other countries. Therefore, the relevance of the present study to cartographic sciences seems evident.

Research object

In its **broad sense**, the research object is investigation of all geography and history atlases used by the Lithuanian schools. The object in the **proper sense** is investigation of the *systems of cartographic signs* used in the Lithuanian school geography and history atlases.

The aim and tasks of the study

The general goal of the present dissertation is to contribute to improvement of the quality of educational cartographic production. The specific objective is to improve the systems of cartographic signs used in the Lithuanian school geography and history atlases giving recommendations as to compilation of maps and standardisation of cartographic symbols. In order to reach the goal the following **tasks** had to be fulfilled:

1. To analyse the studies of Lithuanian and foreign researchers dealing with the subject matter of the present dissertation.

2. To reveal the conception of standardisation of cartographic signs; to determine the possibilities of standardisation of the systems of cartographic signs used in educational cartographic publications on a national level.
3. To conduct a semiotic analysis of the systems of cartographic signs used in school geography and history atlases.
4. To highlight the problems of perception of cartographic signs and the demand for their standardisation.
5. To determine the limits of graphical information load in the maps of school atlases.
6. To prepare recommendations for improvement and possible standardisation of cartographic signs in school atlases.
7. To develop a database of cartographic signs recommended for school atlases.

Scientific novelty of the study

- The question of standardisation of symbols used in educational cartographic publications is raised for the first time in Lithuania;
- The study represents the first in Lithuanian extensive (covering the years 1996–2011) semiotic investigation of the maps included in the Lithuanian school geography and history atlases;
- For the first time in Lithuania, the evaluation of graphical information load of maps included in school geography and history atlases is conducted using computer technologies;
- The system of cartographic signs developed following the semiotic rules and principles of psycho visual perception and based on the individual results can be used in school geography and history maps.

Maintained propositions

1. It is expedient to base the qualitative analysis of cartographic sign systems on qualimetric method adapted to analysis of educational geography and history atlases.
2. Lack of standardisation on a national level affects the perception of cartographic signs and cartographic images by students.
3. Standardisation of cartographic signs used in school atlases should take into account the needs and opinion of the users.
4. The following key measures should be applied for improvement of sign systems in educational geography and history atlases: correct classification of signs into semantic groups, relevant demonstration of interrelations of cartographic signs, pronounced transitive expression, and usage of optimal cartographic bases.
5. The communicative quality of school geography and history atlases would be strongly improved using the recommended sign systems.

Approbation of research results

The research results were published in 5 scientific articles and presented at two international scientific conferences and two national scientific conferences (a list of scientific publications and conference presentations is given in the final section underneath the summary in English).

Extent and structure

Following decision No VI-4 of 2003 of the Lithuanian Science Council, the dissertation is composed of the following main sections: Introduction, Survey of Researches, Methods, Results, Conclusions, List of References and Annexes. The work

includes 255 figures (diagrams, schemes and sketch maps), 28 tables, and 280 entries in the list of references (without cartographic publications).

1. METHODOLOGY

Semiotic analysis of the system of cartographic signs (in geography and history atlases)

Taking into consideration the specific users – students (young people striving for knowledge) – and designation of maps (to illustrate the material presented in geography and history lessons and to facilitate assimilation and memorization of information), the maps published in the school geography and history atlases and the systems of cartographic signs used in them should answer certain requirements which usually depend on the age of target users. The systems of cartographic signs should be developed taking into account not only principles of psycho visual perception but also the cartographic semiotics. (Dumbliauskienė, 2002). These both aspects are in close relationship.

It is very important that simple cartographic signs are dominant in school maps irrespective of the target age group. Simplicity facilitates easier memorisation and perception. In the cartographic production designed for the youngest users (students of 1th–4th grades), imitating/stylized (photographs would be the best choice) signs of colours identical to the signified objects should be dominant. In the maps designed for students of the 5th–8th grades, the mentioned imitating/stylized signs should be used in combination with as many as possible cartographic signs resembling in their form and colour the signified objects, i.e. symbolic conventional signs of symbolic colour. The maps for students of the 9th–10th grades should mainly use symbolic conventional signs of symbolic and/or indifferent colours. The cartographic products for senior students of the 11th–12th grades should not avoid abstract conventional signs along with the symbolic ones (the signs of both types should be of either symbolic or indifferent colour).

The cartographic signs in the legends of maps designed for all age groups of students should be correctly semantically grouped. It is strongly recommended that the groups of cartographic signs in the legends of maps targeted at the younger users (grades 1–4 and 5–8) are titles (e.g. valuable minerals, settlements, stockbreeding, etc.). The taxonomic differentiation and transitive expression also should be correct.

Bearing in mind the age of students, it is important to choose relevant/acceptable graphic and information loads. The graphic and information overloads should be avoided since they encumber the reading of cartographic products, decoding of the contained information and its perception and memorization. The underload also is unwelcome as it makes a map uninformative and reduces its usefulness.

It is of key importance that an optimal cartographic base is chosen; especially in respect to the theme of the map. This element of cartographic product is expected to facilitate quick orientation in the map for completion of set tasks. In order to attract students' attention and to interest them it is necessary to use original graphics. The graphic originality is especially welcome in the maps used by younger students (grades 1–4 and 5–8). In the maps designed for students of grades 9–10 and 11–12, the graphic originality could be moderate. The maps which meet the mentioned requirements can be regarded as being of good readability what is mandatory for maps designed for all age groups of students.

The **semiotic analysis** of maps used in school geography and history atlases was conducted based on the method of qualimetric analysis of thematic maps suggested by M. Dumbliauskienė (Dumbliauskienė, 2000) which is focused on determining the quality of the systems of cartographic signs from the point of view of semiotics. The method was partly transformed (the number of indices was reduced) applying it for semiotic analysis of maps used in Lithuania in school geography and history atlases.

The systems of cartographic signs used in the Lithuanian school geography and history atlases were analysed in three aspects. Valuation criteria, which are critical for correctness, perceptibility and memorisation of signs, were distinguished for every aspect:

1. **Semantic** (French *sémantique – meaning* < Ancient Greek. *sēmantikos – important*) aspect. In this aspect, the relationships between the signifiers and denotations.
2. **Syntactic** (Ancient Greek *syntaktikos – pulling together*) aspect. The interrelations of signs are investigated.
3. **Pragmatic** (practical; Ancien Greek *pragmatikos – from pragma, pragmat – deed*) aspect. The relationships (perception, communication) between the users and the system of cartographic signs are investigated.

Semantic aspect of semiotic analysis

For **semantic aspect**, the **associative capacity of the shape** and **colour of signs**, which help to recognize the denoted object, were evaluated. The associative capacity of the shape and colour of sign reflects the degree of relationship with denotations.

Analysing the **associative capacity of the shape**, the following features were *Imitating/stylized signs* (they also are called icons) – they are drawings (often photographs), which resemble (only their form or in their form and colour) the denominated objects, phenomena and processes, e.g.  is a sign for cotton maintaining resemblance of form and colour;  also stands for cotton but bears a resemblance with the signified object only in its form.

Symbolic conventional signs denominate the object, phenomena and processes according to their typical attribute. For example  – flask used in chemical laboratories – is a sign for chemical industry;  – tricolour points the location where Lithuania's independence was enounced.

Abstract conventional signs signify objects, phenomena and processes by agreement within a certain system of symbols. In their shape, such signs are least resembling the denoted objects. Commonly these are geometric figures whose meaning is difficultly perceived without a legend. E.g.  – nickel ore,  – universities,  – customs, etc.

The **associative capacity of colour** is another not least important index for semantic evaluation. The colour of cartographic signs may be *identical* with the colour of denoted object, phenomenon or process, e.g.  – citruses are associated with yellow colour or  – grapes are usually associated with green colour. Also a *symbolic* colour is distinguished, e.g.  – stands for automotive industry which associates with cold metal colour;  – for plotting revolts, the signs usually are red, which is an intensive "aggressive" warning colour. *Indifferent* colour also is distinguished, which has nothing in common with the colour of denoted objects, phenomena or processes. For example sign  – for citruses is light brown though yellow would seem more relevant; – stands for pipelines though grey or black would suit more.

Table 1. The table as an example for the research of signs in the aspect of semantics

No.	Title of the map	The number of the page	Shape of the sign			Colour of the sign			Shape of the sign			Colour of the sign			Shape of the sign			Colour of the sign			Shape of the sign			Colour of the sign		
			Imitating/stylized	Symbolic conventional	Abstract conventional	Identical	Symbolic	Indifferent	Imitating/stylized	Symbolic conventional	Abstract conventional	Identical	Symbolic	Indifferent	Imitating/stylized	Symbolic conventional	Abstract conventional	Identical	Symbolic	Indifferent	Imitating/stylized	Symbolic conventional	Abstract conventional	Identical	Symbolic	Indifferent
(Title of geography or history atlas for school)																										
			Point signs						Line signs												Area signs					
									Signs lines						Signs vectors											
1																										
2																										

Based on the chosen valuation indices and distinguished attributes, a table of evaluation/analysis was compiled in which the signs are divided into three main groups: point, line (they are further subdivided into signs lines and signs vectors) and areal signs (Table 1).

Syntactic aspect of semiotic analysis

For **syntactic aspect**, **semantic** and **taxonomic differentiation** and **transitive expression** indices were distinguished which help to correct the signs taking into consideration the interrelations (reflecting the real links with the denotations).

The **semantic differentiation** is related with the cartographic signs included in the legends of maps. This index serves as a base for strictly logical and meaningful grouping of signs according to certain attributes and facilitates the readability of maps. For example, for mapping of economic activity, semantic groups of signs for stockbreeding, plant growing, and exploitation of mineral resources are distinguished. Semantic differentiation of religions further subdivided into Christianity, Islam, Buddhism, etc. and further, may serve as another example. The semantic differentiation is of key importance in complex maps with long and sophisticated legends.

Structuring of cartographic signs facilitate correction even of the shape and colour of signs. E.g. letter symbols (according to periodic table of elements) written within certain geometrical figures are used in the maps of valuable minerals E.g. ferrous metal ores are marked by blue triangles Mn, Ni, whereas ores of non-ferrous metals are marked with yellow ovals Cu, Au. Using this system, the maps are not overloaded with a great number of different signs what makes the perception and memorization easier.

Every thematic map has individual semantic differentiation as every such map presents unique information. Similarities can be observed only between maps of the same theme but issued by different publishing houses.

The semantic differentiation in school geography and history atlases may be *correct, partly correct* or *not expressed* (Table 2).

Table 2. Features of semantic differentiation and their description

Semantic differentation		
Correct	***Partly correct***	***Not expressed***
▪ In the legend, the cartographic signs are clearly grouped according to certain features. The distinguished groups are titled. ▪ 2-3 semantic groups of signs are used.	▪ Most of the cartographic signs in the legend are grouped according to certain features but the semantic groups not always are titled. ▪ Semantic groups are distinguished yet untitled. Moreover, different groups of signs are not separated (for example by adding space between lines). This makes the semantic differentiation difficult to comprehend.	The map depicts one object, phenomenon or process with few features. Therefore, the legend is simple. Only a few signs are explained.

The taxonomic differentiation shows the hierarchic relationships of cartographic signs and real objects. The demonstration of these relations through thickness, texture, colour and shape of *lines*, colour, font style and size of *letterings*, colour and its intensity, shape, orientation and size of *point signs*, and colour and shading intensity of *areal signs*, helps map user to understand the hierarchy and ranks of depicted objects, phenomena and processes. Taxonomic differentiation of settlements – capital cities, administrative centres, urban settlements, and rural settlements – may serve as one of the best examples. The taxonomic hierarchy usually is revealed through signs of different shape and size for different types of settlements. Usually puansons of different size and structure are used yet sometimes also other geometrical figures appear, e.g. squares or perspective signs images.

For taxonomic differentiation, the following categories were distinguished: *correct, partly correct* and *not expressed* taxonomic differentiations (Table 3).

Table 3. Features of taxonomic differentiation and their description

Taxonomic differentation		
Correct	***Partly correct***	***Not expressed***
▪ The relation with a real object, phenomenon or process is clearly visualised through respective features: shape and size of signs and colour and shading intensity. ▪ A simple hierarchic structure of signs is use: 3–4 hierarchic ranks of signs are dominant.	▪ Most of the used cartographic signs are correctly taxonomically differentiated yet not all of them. ▪ The hierarchy of cartographic signs is poorly visualised, e.g. graphic signs hardly differ in size and the differences of line thickness or colour and shading intensity are hardly discernible.	The theme of the map is narrow and does not require visualisation of the links between the cartographic signs and real objects, phenomena or processes (few cartographic signs are used; the hierarchic links between signs are absent).

The ***transitive expression*** describes the correctness of quantitative, qualitative and proportional scales used in a map, which provide an opportunity to the map reader to compare the plotted objects, phenomena and processes and, simultaneously, to get concrete information (Dumbliauskienė, Ročiūtė, 2009). This index is expressed in colours and the intensity of shadowing. The colour and shadowing scales are not random but based on semantic and logical principles in an increasing or decreasing succession of the chosen index (Dumbliauskienė, 2000 a).

In order to express the quantitative attributes of an index, one colour of different intensity is used. The same is true about the shadowing intensity. The transitive expression also may be achieved through signs of different size (quantitative scale). Maps of population density, where the chosen colour intensifies with increasing number of population (quantitative attribute), may serve as one of the simplest examples. Moreover, the colours are chosen following the semantic rules – commonly warm colours are used.

The qualitative attributes of an object, phenomenon or process are plotted using different colours and shadowing. For example, in the water pollution maps, the clean water is plotted in blue, little polluted in green, averagely polluted in yellow, strongly polluted in pink and heavily polluted in red.

In the school geography and history atlases, the transitive expression may be *correct, partly correct* or *not expressed* (Table 4).

Table 4. Features of transitive expression and their description

Transitive expression		
Correct	***Partly correct***	***Not expressed***
▪ The colour and shading scales and	▪ The colour and shading scales and size of	The theme of the

size of signs are not random. They are selected following principles of logic and semantic rules. The scales clearly visually differ in size: colour transitiveness and intensity are correct, shading intensity is clear as is the difference between the sizes of the used signs. ▪ The number of intervals is optimal: maximum 5–6 intervals.	signs are not random. They are selected following principles of logic and semantic rules. The small and large scales are not clearly discernible: distinguishing between colours and shades and size of signs requires effort. ▪ The scale interval is at variance with the principle of transition: a colour, a shade or one of the signs falls out of the context. ▪ 7 or even more intervals are used.	map does not require transitive expression index.

Based on the chosen evaluation indices and their attributes a table of evaluation–analysis of syntactic aspect was compiled (Table 5).

Table 5. The table as an example for the research of signs in the aspect of syntactics

No.	**Title of the map**	The number of the page	**Semantic differentation**			**Taxonomic differentation**			**Transitive expression**		
			Correct	Partly correct	Not expressed	Correct	Partly correct	Not expressed	Correct	Partly correct	Not expressed
(Title of geography or history atlas for school)											
1											
2											

Pragmatic aspect of semiotic analysis

In **pragmatic aspect**, the following indices were distinguished: **graphic** and **information load** of cartographic image, **optimality of cartographic base**, **graphic originality**, **standardisation level**, and **readability** of map. During the investigation in pragmatic aspect, the whole of cartographic signs and general cartographic image and its perception are evaluated.

The **graphic load** of a map is reflected in the density of cartographic signs and letterings, which can be evaluated visually and calculated using computer programs (provided that digital data is available) and certain formulas.

In the present semiotic study, the graphical load was evaluated visually as calculations are a complex and time-consuming task and they were not included in the objective.

For evaluation of graphical load, the following features were distinguished: *overload, acceptable* and *underload* graphic load (Table 6).

Table 6. Features of graphic load and their description

Graphic load		
Overload	***Acceptable***	***Underload***
Very many signs and letterings: - cartographic signs and letterings drown in each other; - signs are indiscernible and hardly recognizable; - letterings are almost illegible; - there are difficulties in associating letterings with objects.	Letterings and signs are not many: - signs and letterings do not drown in each other; - signs are easily discernible and recognizable; - letterings are easily readable; - letterings are easily associated with objects.	▪ Mapping is performed by cartogram method; ▪ Low density of signs and letterings; ▪ Many "free" areas: signs and letterings are concentrated in one or a few small areas.

The **information loa*d*** of a map depends on many things; firstly, on the graphic load. Though these two indices are especially closely related they are not identical since the amount of information in a map depends not only on the number of cartographic signs and letterings but also on the character and different gradations of cartographic signs, links between signs and textual information, links between thematic elements and cartographic base, etc. (Berliant, 1986; 2002; 2003; Dumbliauskienė, 2002). The

information contained in maps is of two types: direct and indirect (potential). The latter makes the calculation of this index more difficult than the calculation of graphic load. The potential (hidden) information depends solely on the map "readers". The users of cartographic products are very different. Firstly they are of different age, what predetermines different life experiences. Secondly, they are of different intelligence and education. For this reason, the calculation of the total information load in a map (direct + indirect information) is especially difficult.

In this study, the information load of maps was evaluated visually for the same reason as with the graphic load (too time-consuming and complex calculations).

For evaluation of the information load, the following features were chosen: *overload, optimal* and *underload* (Table 7).

Table 7. Features of information load and their description

Information load		
Overload	***Optimal***	***Underload***
▪ A great variety of signs: signs of different shapes and colours are used; ▪ A great variety of letterings; ▪ Especially detailed quantitative and qualitative scales are used (more than five intervals); ▪ A complicated hierarchic sign structure is used.	▪ Information is represented using 2–3 semantic groups of signs; ▪ The hierarchic structure of signs is simple: 3 hierarchic levels are dominant; ▪ The qualitative and quantitative scales have 5 intervals or categories at most.	▪ Only one object, phenomenon or process is depicted; ▪ A few objects, phenomena or processes are depicted yet their territorial distribution is limited; they have few informative attributes.

The **cartographic base** is one of the key elements of thematic maps as without it the presented information would be a mingle-mangle of graphic signs of no value. This element of a map helps to orientate in space and to perceive and assimilate the conveyed information. The cartographic base – the number and detail of its elements, depends on the theme and scale of the map. The scale predetermines the level of generalization of the cartographic grid elements. It should be pointed out that thematic maps of all kinds must have settlement and hydrographic networks and, what would be welcome, cartographic grid and administrative distribution. In nature maps, along with the mentioned elements of cartographic base, relief and forests are plotted. Human thematic maps depict networks of roads and railways.

In the present study, the level of optimality of cartographic base was evaluated: *optimal, medium optimal* and *not optimal* (Table 8).

Table 8. Features of cartographic base and their description

Cartographic base		
Optimal	***Medium optimal***	***Not optimal***
When most of the following elements are plotted : ▪ Cartographic grid (irrespective of the theme or scale of the map); ▪ Hydrographic network, i.e. rivers, lakes, seas and other big bodies of water with names indicated (irrespective of the theme or scale of the map); ▪ Administrative territorial distribution (irrespective of the theme or scale of the map); ▪ Capitals and main cities of countries with names given (irrespective of the theme and scale of the map); ▪ Relief (with respect to the theme of the map); ▪ Forests (flora) (with respect to the theme of the	▪ When only some of the elements of cartographic base listed in the section "Optimal" are plotted. Some of the elements due to be plotted with respect to the scale and theme of the map are missing, e.g.: - cartographic grid is missing; - names of some administrative territories are not given (in small scale maps); - not all capital cities of the countries are plotted and named (in small scale maps). ▪ The elements of cartographic base are rather generalised, i.e. lack detail,	When are plotted: ▪ Only administrative territorial distribution without indication of the names of the plotted territories; ▪ Administrative territorial distribution and a few largest rivers without

map); ▪ Network of motor roads and railways (with respect to the theme of the map).	e.g.: the river network is too generalised, names of rivers are not given (in the maps of all scales).	names (in large scale maps).

Graphic originality refers to unconventional map elements, expressive forms, striking yet well matched and harmonious colours, nonstandard typography, and original complementary information – photographs, caricatures and diagrams. All these elements attract readers' attention, strengthen the impression, improve the readability of maps, and facilitate easier perception and memorization of presented information. This index is especially important and welcome in school cartographic production (the one used by younger students in particular).

Graphic originality may be *pronounced, moderate* and *absent* (Table 9).

Table 9. Features of graphic originality and their description

Graphic originality		
Pronounced	***Moderate***	***Absent***
▪ Original depiction techniques attracting user's attention are used: - echnique of symbols – especially original imitating/stylised (photographs) or unusual symbols are used; - technique of qualitative/ quantitative background – especially well matched (between themselves and with other signs) colours and original shades are used to attract user's attention. ▪ An original cartographic base is used, e.g. shadowed relief strengthening perception; ▪ Original shades are used.	▪ Only a small part of the graphic image is marked by original expression: e.g. only a few attractive cartographic signs (imitating/stylized or symbolic conventional signs) are used which hardly facilitate the general perception of the cartographic image; ▪ Well matched colours and/or shades are used yet they are not strongly attracting attention**i**; ▪ Traditional easily readable letterings are used.	Undistinguished depiction techniques are used, which do not attract user's attention and do not facilitate (in many cases even encumber) the readability of the cartographic "text": - the cartographic signs used are simple and undistinguished; in the majority of cases they are difficultly perceivable abstract conventional signs - the colours used lack expressivity; they are not contrasting and not harmonised; - the shades are undistinguished and not attractive; - the letterings are simple and undistinguished.

The index of **standardisation level** studied in the present work may be described as: *standardised, partly standardised* and *not standardised* (Table 10). This index is analysed only in those school geography atlases which use standardised or partly standardised systems of cartographic signs. When in a map only some cartographic signs are standardised and the rest are not standardised or partly standardised, the level of standardisation of such map is classified as partly standardised. In the maps of history atlases, the systems of cartographic signs are not standardised.

Table 10. Features of standardisation level and their description

Standardisation level		
Standardised	***Partly standardised***	***Not standardised***
Nationally and internationally standardised mandatory systems of cartographic signs are used. Such are *geological, soil, physical geographical* and *synoptic* maps. Usually maps of these types are easily readable and perceptible. Those who have practice in reading these thematic maps usually do not need to refer to the legend.	Institutionally standardised systems of signs are used. In the course of time, standards of representing certain objects become established (e.g. colours for different zones in maps of vegetation zones or colours representing different stands in maps of forests) though not approved by appropriate organisations. Usually, cartographic signs of this kind are standardised based on one attribute: colour or shape. These maps are sufficiently easily readable because at least some of the used signs can be recognised without referring to the legend; especially if the user has practice of reading maps of these kinds.	The used systems of cartographic signs are not internationally, nationally or institutionally standardised. In order to understand them, reference to the legend is necessary what encumbers fast reading and perception.

The **readability** of maps depends on all the mentioned indices since they to smaller of greater extent facilitate (imitating/stylized or symbolic conventional signs, signs of identical or symbolic colours, correct semantic and taxonomical differentiation, optimal cartographic base, acceptable graphic load, pronounced graphic originality, etc.) or encumber (abstract conventional signs of indifferent colours, incorrect semantic and taxonomic differentiation, not optimal cartographic base, etc.) the reading of cartographic product.

Taking into account the mentioned indices, the readability of cartographic production was evaluated as: *good*, *encumbered* and *bad* (Table 11).

Table 11. Features of readability and their description

Readability		
Good	***Encumbered***	***Bad***
▪ Imitating/stylised and/or symbolic conventional signs are used of identical or symbolic colour; ▪ The used signs and letterings do not drown in each other; ▪ The colour (and its intensity) and size of signs make possible their easy discernment on the cartographic base; ▪ Signs are easily distinguished from each other; ▪ Letterings can be easily attributed to relevant objects; ▪ Cartographic signs in legends are correctly semantically and taxonomically differentiated; ▪ Optimal cartographic base is used; ▪ Correct colour and/or shading scales are used. They are not random but selected sticking to the principles of logic and semantic rules; ▪ Transitive expression index is represented by an optimal number of intervals: maximum 5–6 intervals; ▪ The information is represented using 2–3 semantic groups of signs; ▪ The qualitative and quantitative scales are composed of 5 intervals or categories at most; ▪ The used cartographic signs are internationally and/or nationally standardised; ▪ Manifold depiction used for communication of high information load; ▪ The cartographic methods employed are original and attracting user's attention.	▪ Symbolic conventional signs are dominant; only a small number of imitating/stylised and abstract conventional signs are used; ▪ The used signs are difficultly discernible in the background due to similar colour; ▪ Some of the used signs are too small or too inconspicuous to distinguish between their shape and/or colour; ▪ There are rather many letterings; ▪ Semantic and taxonomic differentiation are only partly correct; ▪ The cartographic base is of medium optimum; ▪ Transitive expression index is represented by 6–8 intervals; ▪ The used cartographic signs are institutionally standardised.	▪ Abstract conventional signs are used; ▪ Signs in the map legend are not semantically grouped (logical groups are absent); ▪ Hierarchic relations between the signs and signified real objects, phenomena and processes are incorrect; ▪ Signs and letterings are rather variable in shape and colour and drown in each other (graphic overload); ▪ Signs are too small or inconspicuous to distinguish between their shapes; ▪ he used qualitative and quantitative scales are especially detailed (more than 5 intervals); ▪ The used cartographic base is not optimal; ▪ The colours and shades are too intensive (transitive expression) what encumbers distinguishing the cartographic signs in the background; ▪ Systems of cartographic signs are not standardised.

As in the case with the semantic and syntactic evaluation, the pragmatic evaluation based on the chosen criteria and indices is shown in a table (Table 12).

Table 12. The table as an example for the research of signs in the aspect of pragmatics

No.	**Title of the map**	The number of the page	**Graphic load**			**Information load**			**Cartographic base**			**Graphic originality**			**Standardisation level**			**Readability**		
			Overload	Acceptable	Underload	Overload	Optimal	Underload	Optimal	Medium optimal	Not optimal	Pronounced	Moderate	Absent	Standardised	Partly standardised	Not standardised	Good	Encumbered	Bad
(Title of geography or history atlas for school)																				
1																				
2																				

Evaluation of visual perception of cartographic signs (using questionnaires) method

Semiotic analysis of the systems of cartographic signs used in the maps of Lithuanian school geography and history atlases revealed their merits and faults. In order to determine the perception of cartographic signs by students and to prepare recommendations for improvement of the systems of cartographic signs used in the Lithuanian school geography and history atlases, a survey of students and teachers (using questionnaires) was conducted.

Target groups of survey. For the survey *students of grades 6–12* and *geography* and *history teachers* were chosen.

Sample size. For any survey it is important to establish the number of persons to be interviewed in order to make statistically significant conclusions. The confidence of the sample is predetermined by the number of observation units – the volume of sample. The sample is calculated from within population using V. I. Paniotto's formula (Paniotto, Maksimenko, 2003; Bitinas, 1974; Kardelis, Sapagovas, 1998; Kardelis, 2007), which allows calculating the sample without an experimental survey:

$$\mathbf{n = 1/(\Delta^2 + 1/N)}$$

n – sample size (number of cases in the selective group);

Δ – 0.05 error at 95 % confidence (these indices are regarded sufficient from the point of view of representativeness (Kardelis, 2007));

N – the population size (number of cases).

According to the data from the Centre of Information Technologies in Education, in 2011–2012, 991 Lithuanian schools had 250240 students in grades 6–12, 1 246 teachers of geography and 2 036 teachers of history.

The calculations conducted using V. I. Paniotto's formula and standard error 5 % showed that for representative results the minimal number of respondents should be: 399 students, 302 geographers and 334 teachers of history.

The methods of selection of respondents. For representativeness of survey results collected through questionnaires, probability simple random sampling and probability nested sampling were applied. Applying the method of nested sampling, schools were selected in the first place and then grades in these schools. The students within grades were selected by simple random choice. I.e. from the list of population the intended number of population members was chosen randomly. The students were chosen irrespective of the learning results and the like.

The conditions of survey. The survey was conducted using four questionnaires. One of them is designed for students of grades 6–8, the second for students of grades 9–12, the third for geography teachers and the fourth for history teachers.

The survey was anonymous. The questionnaires for students were printed on sheets of paper. The survey was conducted in eleven schools of four Lithuanian cities: Vilnius, Kaunas, Utena and Gargždai. Schools of different types were chosen: one basic school, three pro-gymnasiums, four gymnasiums, one lyceum, one private and one professional school.

The questionnaires for teachers were of digital form, placed in portal www.apklausa.lt. The invitations to fill the questionnaires were disseminated in a few ways: e-mailed to Lithuanian school offices and to deputy directors for education with request to encourage geography and history teachers to take part in the survey; e-mailed

directly to teachers whose contact data were found on the internet; leaflets inviting to participate in the survey were distributed among teachers of geography at seminars held in Vilnius; teachers were encouraged to fill the forms and participate in the survey also in the article published in the internet page of the Lithuanian Association of Teachers of Geography (www.geografija.lt); an invitation to participate in the survey also was mailed to the Lithuanian Association of Teachers of History.

Structure of questionnaires. The beginning of every questionnaire was supplied with a brief description of the research and a list of used terms (notions; in the questionnaires only for teachers). The description is followed by a brief explanation how to fill the questionnaire. The main part of the questionnaire included social demographic questions followed by questions of closed, semi-closed and open type.

The first block of questions in students' questionnaires were related with school geography atlases, the second with school history atlases, the third included general questions about cartographic signs, their perception and standardisation, the fourth block contained map fragments with the aid of which an attempt was made to determine the preliminary limits of the volume of optimal graphic information of maps.

The first eight questions in the teachers' questionnaires are closed and semi-closed, short and simple therefore not requiring much time and thinking for answering. The first questions are designed to find out what atlases were used during lessons, why they were chosen, and whether they answered the students' requests. Somewhat more difficult were the questions about perception of cartographic signs in different grades and their standardisation. The ninth question is complex (composed of six short questions), i.e. considerably more sophisticated than the previous ones. This question requires more thinking, effort and time as it asks to evaluate the fragments of maps and to answer short questions about them. Teachers were asked to evaluate more maps than students.

Filling of questionnaires. The questionnaires had to be filled in an academic hour (45 min). Students were not allowed to bring the questionnaires home. The questionnaires had to be filled during geography lessons. These precautions were taken in order to obtain possibly most reliable data preventing dishonest answers.

Methods of data analysis. The collected data were entered and processed using statistical methods designed for description and analysis of digital data and drawing reasonable conclusions about the research object.

MS Excel program was used for this purpose. The used statistical processing methods were: data queues, percentage evaluation of data, size of the situation – average, etc. diagrams were made using this program.

2. RESEARCH RESULTS

SEMIOTIC ANALYSIS OF THE SYSTEMS OF CARTOGRAPHIC SIGNS

Semiotic analysis of the systems of cartographic signs used in the Lithuanian school geography atlases

Semiotic analysis of geography atlases used by the Lithuanian schools included investigation of cartographic signs used in 1 263 maps (Table 13) published in 17 Lithuanian school atlases. The distribution of cartographic signs in the atlases is uneven.

The cartographic signs were divided into three groups: point, linear (signs lines and signs vectors) and areal signs (Fig. 1). The *areal* signs are dominant in the Lithuanian school geography atlases accounting for almost 49 % of the total. This is predetermined

by a rather big number of small-scale maps in which the information is conveyed by methods of qualitative and quantitative background and isolines with coloured interlayers: geographical zones, quality of life index, birth rate, number of sunny days per year, etc. Also there are many medium-scale maps with dominant areal distribution of objects, phenomena and processes: e.g. agricultural maps depicting the distribution of the cultural plants, vegetables, stock, etc. The sketch map method also is rather widespread: e.g. distribution of some cultures in the mapped territory (e.g. the area, in ha of cultivated land, occupied by wheat) or population in a territory (per 1 km^2), etc.

The *point signs* in these atlases are no less important (Fig. 1). They account for 39 % of the total. This group of cartographic signs is especially widespread in economic maps. This is so because the depicted objects commonly are located in certain spots. The most widespread objects plotted using point signs are: deposits of valuable minerals, their processing centres, other industrial centres, power plants, sea and air ports, etc.

The linear objects are rarest in the school geography atlases. Therefore, it is only natural that only 12.6 % of used cartographic signs are *linear* in their character (lines and vectors) (Fig. 1). These signs are used to plot the boundaries of different areas, expansion trends of some phenomena and objects, etc. For example, lines of different thickness, colour and texture are used to plot rivers, climate belts, platforms of the earth crust, boundaries of oceans and other objects, fault zones, navigation routes, railways, etc. Linear movement signs also are used to depict the routes of expeditions, navigation of vessels (during the great geographical discoveries), sea currents, movement of earth crust platforms, drifting of glaciers, directions of expansion of natural disasters, etc.

Table 13. Analysed school geography atlases and the number of cartographic signs in them

Title of the atlas	Number of the maps in atlas	Point signs	Line signs		Area signs	Number of the signs in each atlas
			Signs lines	Signs vectors		
"Briedis" publishing house:						
I atlas The Earth. Geographical Atlas for the 6th grade (2004)	**11**	19	23	19	28	**89**
II atlas The Earth. Interactive teaching geographical Atlas for the 6th grade (2010)	**20**	30	19	12	90	**151**
III atlas The Earth. Geographical Atlas for the 7th grade (2005)	**61**	143	70	43	238	**494**
IV atlas The Earth. Interactive teaching geographical Atlas for the 7th grade (2010)	**50**	121	58	12	383	**574**
V atlas The Earth. Geographical Atlas for the 8th grade (year of publication is not indicated)	**85**	370	118	7	397	**892**
VI atlas The Earth. Interactive teaching geographical Atlas for the 8th grade (2011)	**52**	352	101	6	327	**786**
VII atlas Geographical Atlas of Lithuania for the 9th grade (1999)	**41**	139	84	3	178	**404**
VIII atlas The Earth. Geographical Atlas for the 9th grade (2005)	**42**	84	62	10	215	**371**
IX atlas The Earth. Geographical Atlas for the 10th grade (year of publication is not indicated)	**46**	174	53	6	191	**424**
X atlas The Earth. School Geographical Atlas (2006)	**209**	704	262	58	950	**1 974**
"Šviesa" publishing house:						
XI atlas We are many – the World is one. Geographical Atlas for the 6th grade (2008)	**20**	88	14	11	139	**252**
XII atlas Geographical Atlas for the 7–8th grades (2011)	**70**	663	83	20	267	**1 033**
XIII atlas Lithuania Europe the World. Geographical Atlas for the 9th–10th grades (2007)	**54**	335	70	4	341	**750**
XIV atlas Atlas of Integrated Geography for Schools (2005)	**88**	405	98	47	648	**1 198**
"Alma littera" publishing house:						
XV atlas The World Atlas. Geography: Nature Economy Population (2008)	**223**	864	70	4	1 045	**1 983**
"Pradai" publishing house:						
XVI atlas Universal World Atlas (1996)	**70**	440	150	30	560	**1 180**
"Didakta" publishing house:						
XVII atlas New World Atlas (2009)	**121**	448	68	54	810	**1 380**
Total:	**1 263**	**5 379**	**1 403**	**346**	**6 807**	**13 935**

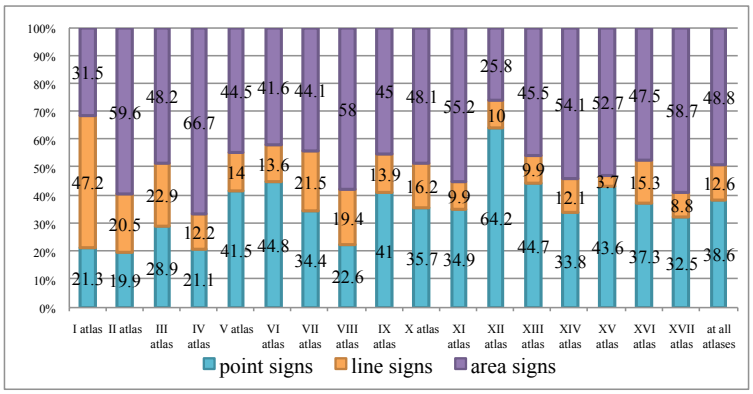


Fig. 1. Distribution of point, line and area signs in the analysed school geography atlases

Semantic aspect of semiotic analysis of cartographic signs

Semantic analysis of cartographic signs used in the Lithuanian school geography atlases revealed that *symbolic conventional signs* commonly are used to convey the ***resemblance of the shape with denoted objects*** (Fig. 2). Signs of this type account for 83 % of the total of signs used in these maps. *Abstract conventional signs* only account for 13 %. The most easily perceived and memorised *imitating/stylized signs* only account for 3.6 % of the total of cartographic signs used in the analysed school geography atlases.

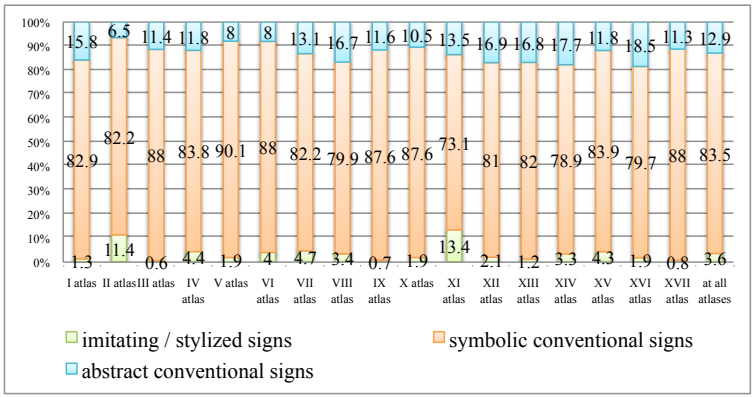


Fig. 2. Association capacity of the shape of signs in the analysed maps of school geography atlases

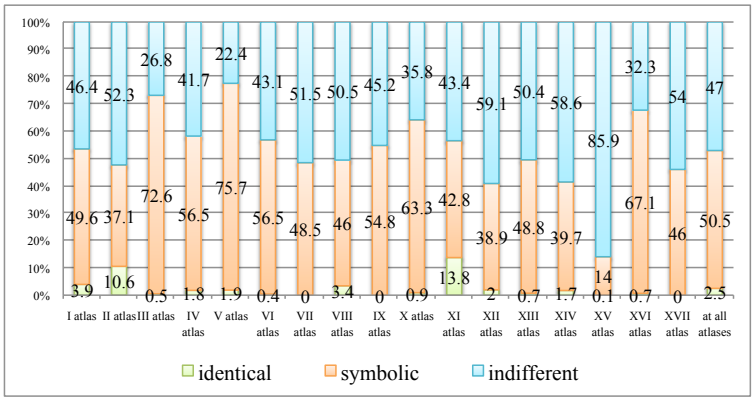


Fig. 3. Association capacity of the cartographic colours in the analysed maps of school geography atlases

Another important index which helps to recognise the depicted object, phenomena and processes is ***associative capacity of the colour*****,** i.e. similarity of the colour to the colour of the signified object, phenomenon or process. Yet it is very difficult to find the colour which would be identical to the denoted object, phenomenon or process.

It was determined that most commonly used in the analysed atlases are *symbolic colours* which account for slightly more than a half (50.5 %) of the total of analysed signs (Fig. 3; Table 14). The cartographic signs of *indifferent colour* account for 47 % of the total. The cartographic signs of *identical colour* comprise the smallest portion in the analysed atlases. They only account for 2.5 % of the total.

Table 14. A copy of notations (a part of signs) used in semiotics analysis

MEANING OF THE SIGNS	USED SIGNS							
Exploitation of mineral resources								
Petroleum								
Uranium								
Industry								
Nuclear power stations								
Car manufacture								
Agriculture								
Plant growing								
Citrus fruit								
Rise								
Stock breeding								
Livestock								
Sheep								
Transport								
Seaports								
Pipelines								

Syntactic aspect of analysis of cartographic signs

Syntactic analysis of the maps published in the Lithuanian school geography atlases showed that the cartographic signs used in the legends to the maps usually are *correctly* ***semantically differentiated*** (Fig. 4). In more than a half (54.1 %) of the legends to the analysed maps are correctly semantically grouped though in many cases the groups of cartographic signs are not titled. In simple maps depicting one or a few objects, phenomena or processes, the semantic differentiation is *not expressed* and, actually it is not necessary. Maps of this kind account for more than one third (38.6 %) of the total. Only in 7.3 % legends of analysed maps cartographic signs are *partly correctly* semantically grouped.

The ***taxonomic (hierarchic) relationships of signs*** conveying the relationships of real objects, phenomena and processes rarely are given in the legends to the analysed maps of geography atlases (Fig. 5). In almost 83 % of the analysed maps, the taxonomic differentiation is *not expressed*. *Correct* taxonomic differentiation was determined in 16.6 % of the analysed maps. And only in 0.5 % of maps the hierarchic relationships are revealed *partly correctly*.

Analysis of all systems of cartographic signs revealed that in more than a half of the maps the ***transitive expression*** is *correct* (Fig. 6). In one fourth of the analysed maps, the transitive expression is *partly correct*. In slightly more than 16 % of maps the transitive expression is *absent*.

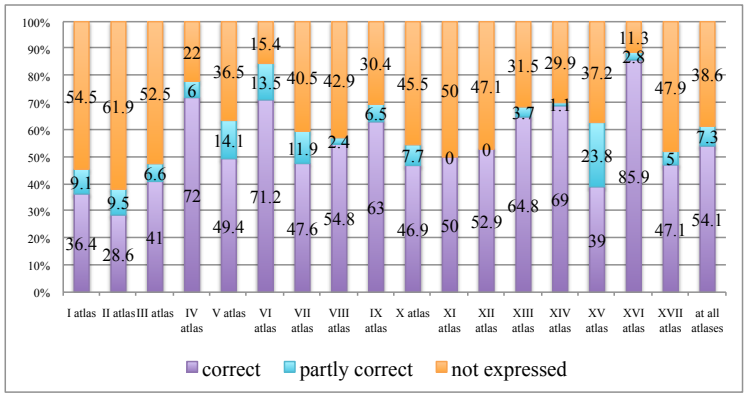


Fig. 4. Semantic differentiation in the legends of the analysed maps of school geography atlases

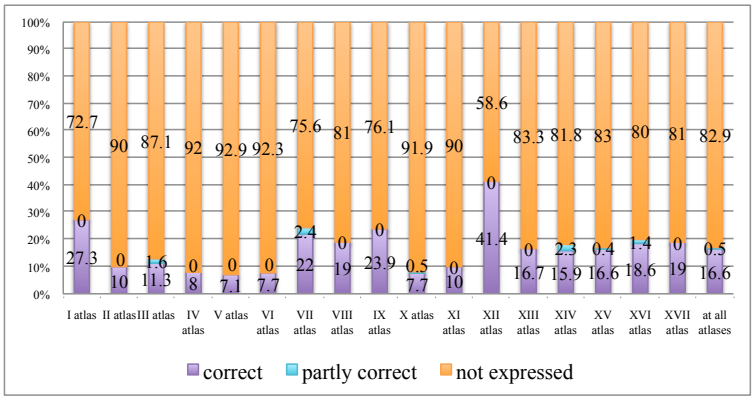


Fig. 5. Taxonomic differentiation in the legends of the analysed maps of school geography atlases

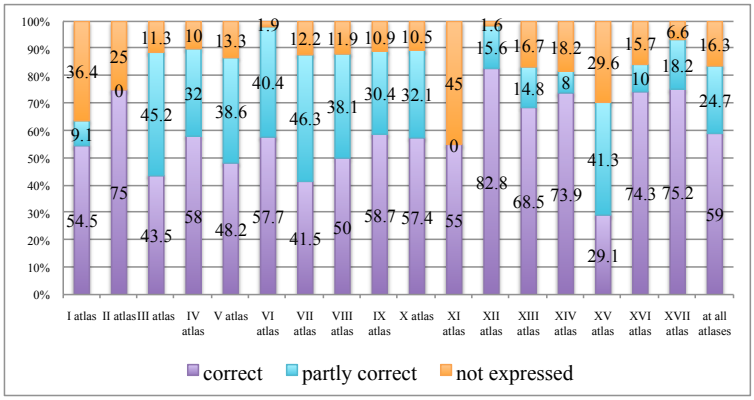


Fig. 6. Transitive expression in the analysed maps of school geography atlases

Pragmatic aspect of analysis of cartographic signs

Analysis in pragmatic aspect showed that the ***graphic load*** of the analysed school geography maps published by various publishing houses is different (Fig. 7). By visual evaluation, the graphic load in almost 60 % of analysed history maps is *acceptable*; in 40 % of maps it is *underloaded* and only in 1.5 % of maps the graphic load is *overloaded*.

The maps published in the Lithuanian school geography atlases are not overloaded with information (Fig. 8). The ***information load*** in the greater part of the analysed maps (82.1 %) is *optimal*. *Overloads* were not observed. *Low information load* was determined in 18 % of analysed maps.

The ***cartographic base***, i.e. mathematical base and geographical elements, is rather important for perception of information contained in maps. Evaluation of cartographic

base of maps showed that even in 46 % of analysed maps the cartographic base is *not optimal* (Fig. 9). In about one third of maps the cartographic base is *optimal* and in almost 23 % of maps it is *medium optimal*.

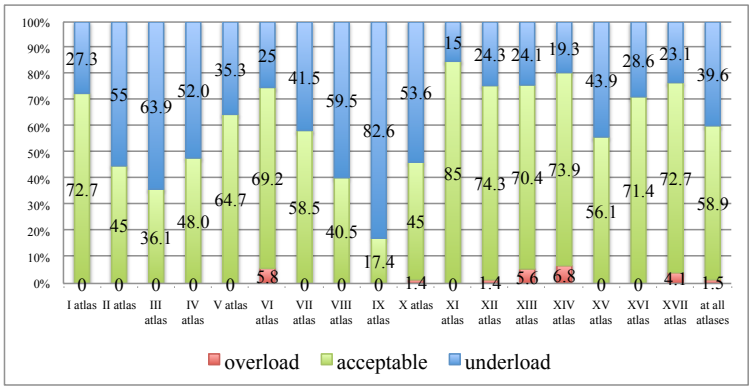


Fig. 7. Graphic load in the analysed maps of school geography atlases

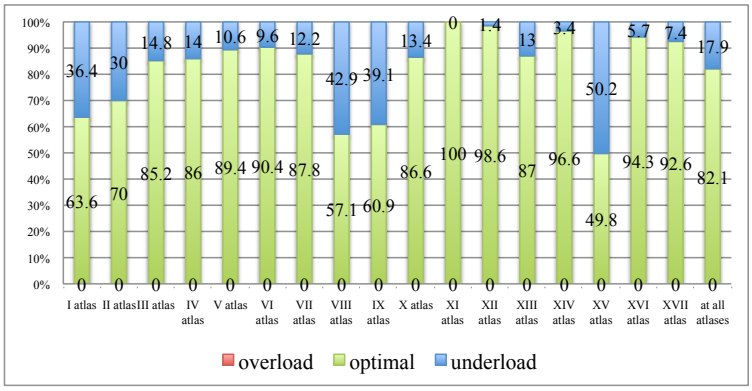


Fig. 8. Information load in the analysed maps of school geography atlases

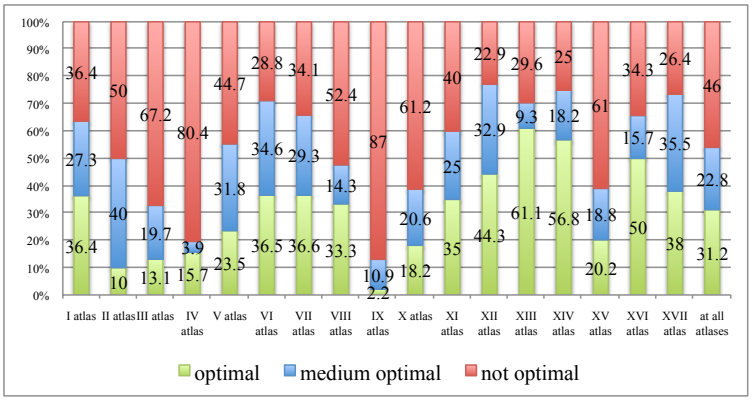


Fig. 9. Optimality of cartographic base in the analysed maps of school geography atlases

Graphic originality is one more very important index which has been forgotten by many map compilers (Fig. 10). More than a half of the analysed maps (57.8 %) *lack graphic originality*. *Moderate* graphic originality was determined in one fourth of the analysed maps. Original graphic depiction (*pronounced* graphic originality) was determined only in 15.3 % of the analysed school geography maps.

Analysis of the systems of cartographic signs revealed that systems of signs in the majority of analysed school geography maps *not* ***standardised***. Maps of this kind account for 64.2 % of the total. *Partly standardised* systems are used in slightly more

than one third (35.8 %) of analysed maps (Fig. 11).

The all above discussed indices of pragmatic aspect are decisive for the especially important communication process – ***readability*** of cartographic production.

The conducted investigation of the maps included in the Lithuanian school geography atlases showed that the readability of more than a half of analysed maps (58 %) is *good* (Fig. 12). The maps of *encumbered* readability account for slightly less than 40 % of the total. Maps of *bad* readability account for 2.5 % of the total.

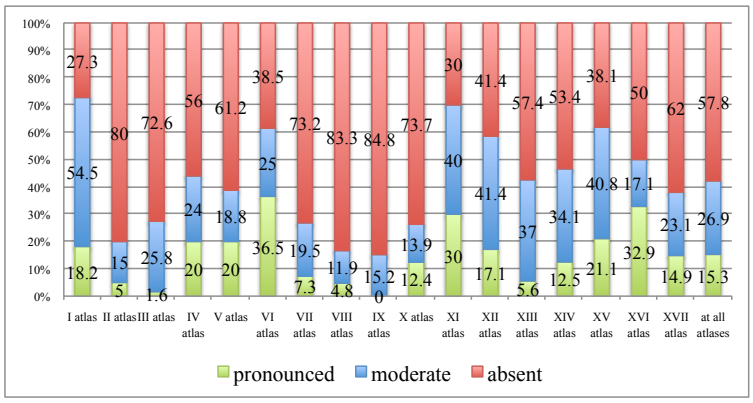


Fig. 10. Graphic originality in the analysed maps of school geography atlases

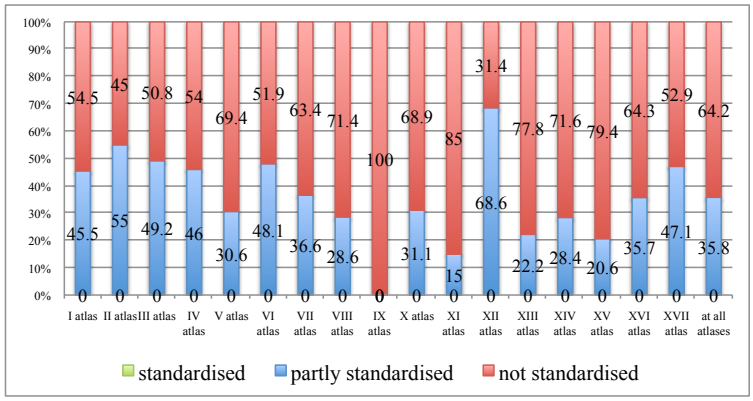


Fig. 11. Standardisation in the analysed maps of school geography atlases

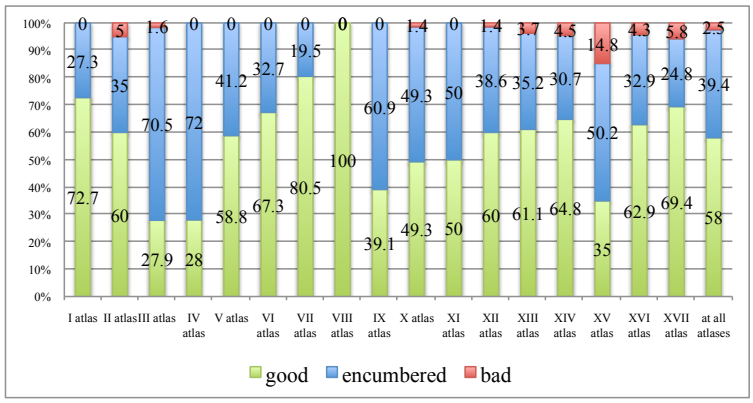


Fig. 12. Readability in the analysed maps of school geography atlases

Semiotic analysis of the systems of cartographic signs used in the Lithuanian school history atlases

Semiotic analysis of history atlases used by the Lithuanian schools included investigation of 7 540 cartographic signs used in the maps (15 lentelė), published in

11 Lithuanian school history atlases. Similarly as in the case with geography atlases, the distribution of cartographic signs in the history atlases is uneven.

Table 15. Analysed school history atlases and the number of cartographic signs in them

Title of the atlas	Number of the maps in atlas	Point signs	Line signs		Area signs	Number of the signs in each atlas
			Signs lines	Signs vectors		
"Šviesa" publishing house:						
I atlas Universal Historical Atlas for Schools (2004)	**74**	199	234	210	453	**1 105**
II atlas In motherland and world. Historical Atlas for the 7–8th grades (2009)	**36**	29	37	43	135	**244**
"Vaga" publishing house:						
III atlas Historical Atlas of Lithuania (2001)	**58**	353	216	106	288	**963**
"Briedis" publishing house:						
IV atlas Historical Atlas of Lithuania (year of publication is not indicated)	**34**	149	109	62	107	**427**
V atlas The Middle Ages Historical Atlas for the 8th grade (year of publication is not indicated)	**54**	152	79	113	214	**558**
VI atlas Mid modern Period Historical Atlas for the 9th grade (year of publication is not indicated)	**47**	162	147	74	162	**545**
VII atlas Contemporary Period Historical Atlas for the 10th grade (year of publication is not indicated)	**57**	159	116	74	272	**621**
VIII atlas Ancient history. Atlas. Conspectus. Vocabulary (year of publication is not indicated)	**37**	96	48	43	142	**329**
IX atlas The Middle Ages. Atlas. Conspectus. Vocabulary (year of publication is not indicated)	**65**	243	129	126	261	**759**
X atlas Mid modern Ages. Atlas. Conspectus. Vocabulary (2010)	**57**	188	126	77	253	**644**
"Naujoji Rosma" publishing house:						
XI atlas The World History Atlas (2001)	**151**	496	226	145	478	**1 345**
Total:	**670**	**2 224**	**1 476**	**1 073**	**2 765**	**7 540**

Grouping (Fig. 13) of all used cartographic signs (as in the case with school geography atlases) allowed concluding that the Lithuanian school history maps are slightly predominated by *areal signs* which account for about 36 % of the total of analysed cartographic signs. This is predetermined by the fact that history maps mainly depict the areal distribution of various objects, phenomena and processes. The qualitative background cartographic method is most common in history maps, e.g. for depiction of territorial transfigurations of states and spread areas of different tribes, religions, language, etc. Also there are many maps compiled using the areal mapping method, e.g. for depiction of military confrontation zones, regions of partisan activity, regions of ancient culture, etc.

Line signs (lines and vectors) also occupy an important place in history maps (Fig. 13). They account for 1/3 of the total of the used cartographic signs. By signs of this group the boundaries of different areas and spread directions of phenomena and objects are plotted. The method of linear depiction is common for history maps. For example, maps of different colour, texture and thickness are used for depiction of the boundaries of empires, states or other administrative units, front lines, ethnic boundaries, frontier fortifications, railways, etc. The method of movement signs also is widely used for depiction of directions of population migrations or deportations, movement of primeval populations, colonisation, etc.

The maps of school history also abound in *point signs* which account for slightly more than 30 % of the total of signs used (Fig. 13). As is known, the point signs are used to plot objects in local points. The usual point objects are: hill forts, cities, castles, battle sites, religious, scientific and cultural centres, trade and crafts centres, military bases, locations of terrorist acts, concentration camps, Jewries, prisons, massacre places, hotbeds of revolutions, air fields, archaeological find places, etc.

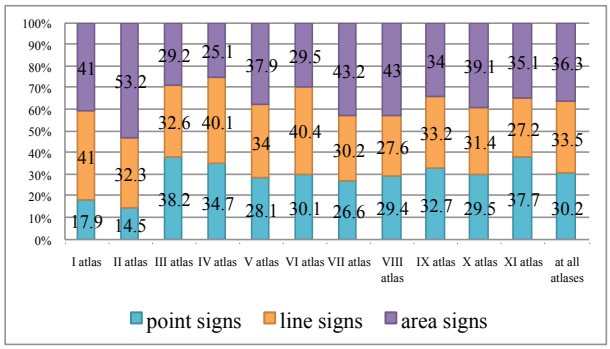


Fig. 13. Distribution of point, line and area signs in the analysed school history atlases

Semantic aspect of semiotic analysis of cartographic signs

The semantic aspect of semiotic analysis of educational history atlases used by Lithuanian schools (Fig. 14; Table 16) revealed that *symbolic conventional signs* commonly are used to convey the ***resemblance of the shape with denoted objects.*** These signs account for more than 85 % of the total of cartographic signs used in the analysed maps. *Abstract conventional signs* only account for 13 %. The most easily perceived and memorised *imitating/stylized* cartographic *signs* are especially rare in the maps of school history atlases. They account for 1.1 % of the total of cartographic signs used in the analysed atlases.

Associative capacity of colours also is of great importance. The choice of identical colours for plotted objects, phenomena and processes is an especially difficult task for the specific character of history maps. In many cases this is impossible. Thus it is natural that *identical colours* in the analysed history atlases hardly reach 1 % (Fig. 15). Cartographic signs of *symbolic colours* are most common (51 % of the total) in the Lithuanian school history atlases. Slightly less common are cartographic signs of *indifferent* colours: 48.4 % of the total.

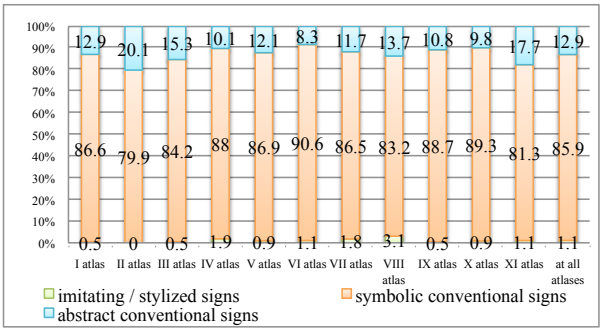


Fig. 14. Association capacity of the shape of signs in the analysed maps of school history atlases

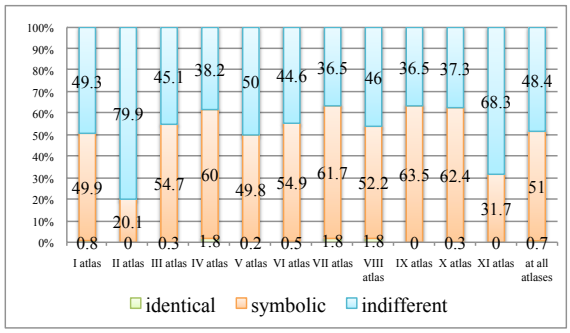
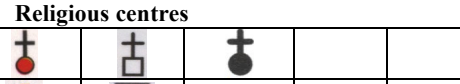
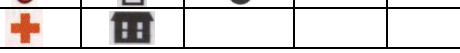


Fig. 15. Association capacity of the cartographic colours in the analysed maps of school history atlases

Table 16. A copy of notations (a part of signs) used in semiotics analysis

MEANING OF THE SIGNS	USED SIGNS							
Cultural centres								
Universities, institutes								
Theatres								
Religious centres								
The centres of dioceses								
Seminaries								

Conflicts, truce, torturing and the places of torture and killings								
Uprisings, the centres of uprisings				Brilis				
Concentration camps								
Boundaries								
GDL wall in the 15th century								
Polish–Lithuanian Commonwealth (Republic) boundaries								

Syntactic aspect of semiotic analysis of cartographic signs

Syntactic analysis showed that cartographic signs used in the legends to the maps published in the Lithuanian school history atlases usually are *correctly* ***semantically differentiated*** (Fig. 16). In about 42 % of the legends to the analysed maps cartographic signs are correctly semantically grouped yet often the groups of cartographic signs are not titled. There are many maps where semantic differentiation is *not expressed* (even 1/3 of the total of analysed maps). In the legends of some maps included in the Lithuanian history atlases, cartographic signs are only *partly correctly* semantically differentiated. Maps of this kind account for about one fourth of the total.

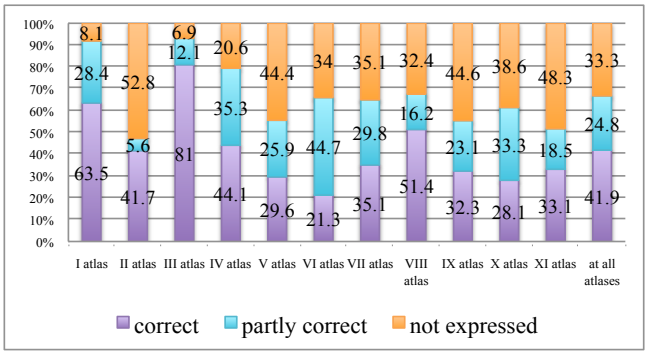


Fig. 16. Semantic differentiation in the legends of the analysed analysed maps of school history atlases

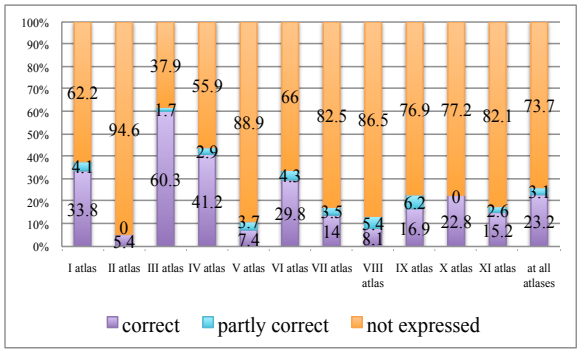


Fig. 17. Taxonomic differentiation in the legends of the analysed maps of school history atlases

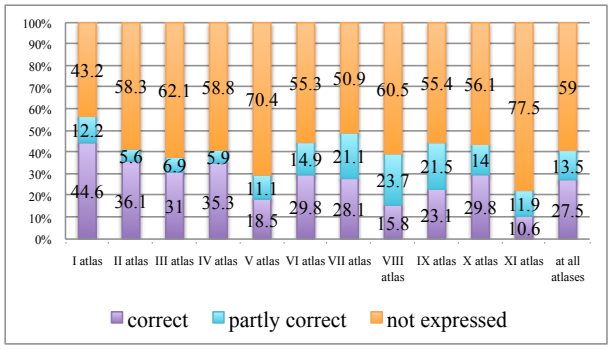


Fig. 18. Transitive expression in the analysed maps of school history atlases

The hierarchic relationships of cartographic signs in the legends of the Lithuanian school history maps are rarely expressed (Fig. 17). In about 3/4 of the analysed maps, the ***taxonomic differentiation*** is *not expressed*. *Correct* taxonomic differentiation was determined in less than 1/4 (23 %) of analysed maps. In slightly more than 3 % of maps, the hierarchic relationships are expressed only *partly correctly*.

Analysis of the systems of cartographic signs in school history atlases also showed that in more than a half of them (59 %) the ***transitive expression*** is *not expressed* (Fig. 18). In more than 1/4 of analysed maps, the transitive expression is *correct* and in 13.5 % of maps it is *partly correct*.

Pragmatic aspect of semiotic analysis of cartographic signs

Analysis in pragmatic aspects showed that (by visual evaluation) almost in 75 % of analysed maps ***graphic load*** is *acceptable* and even in 23 % of maps it is *underloaded* (Fig. 19). There were cases, though few, when maps were *overloaded* with graphic elements (2.4 % of the total).

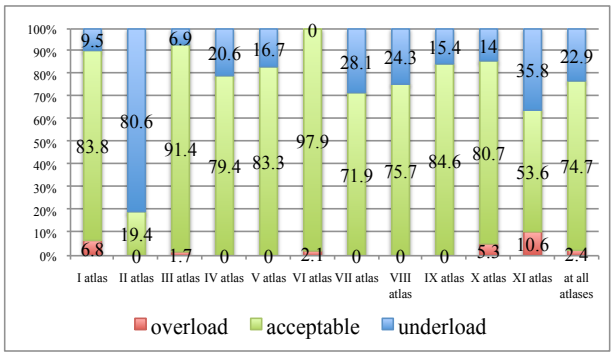


Fig. 19. Graphic load in the analysed maps of school history atlases

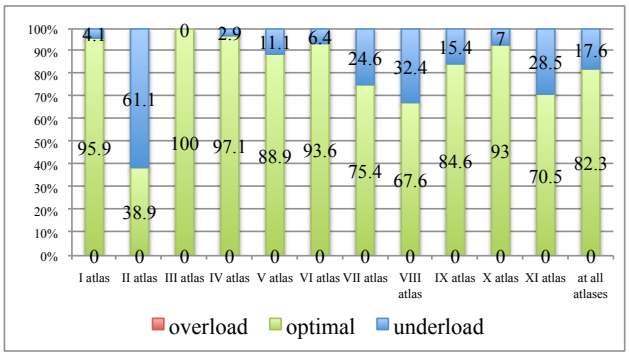


Fig. 20. Information load in the analysed maps of school history atlases

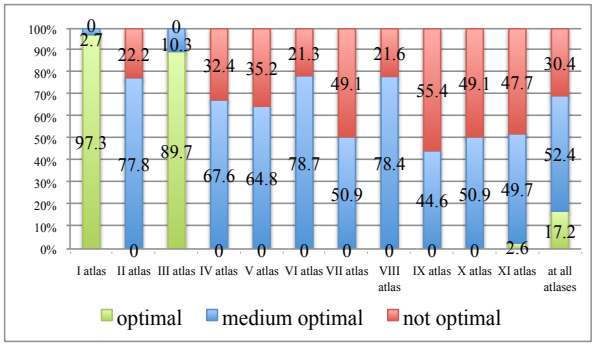


Fig. 21. Optimality of cartographic base in the analysed maps of school history atlases

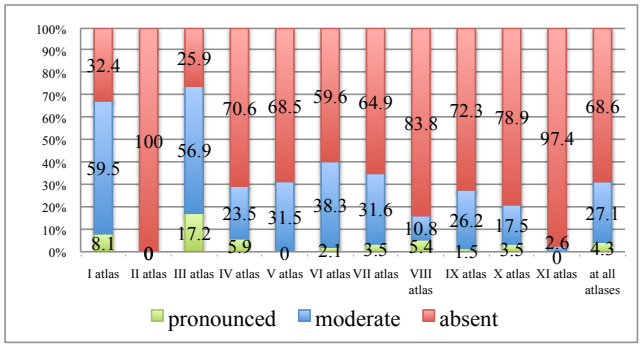


Fig. 22. Graphic originality in the analysed maps of school history atlases

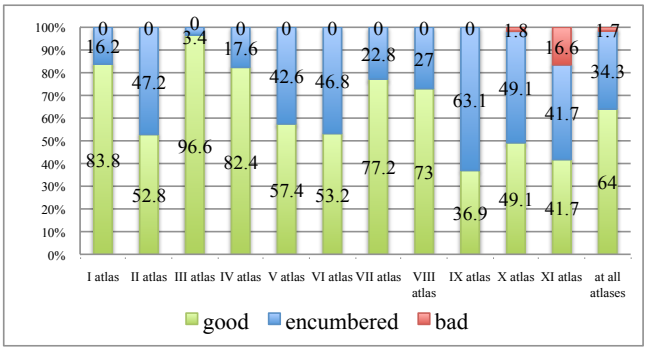


Fig. 23. Readability in the analysed maps of school history atlases

In general, the Lithuanian school history atlases are *not overloaded* with information (Fig. 20). In most of the maps (82.3 % of the total), the ***information load*** is *optimal*. The *underloaded* information load was observed in about 18 % of maps. It should be pointed out that the age of students not always is taken into consideration. The load of information should increase with the increasing age of the users. Yet this not always is the case.

The ***cartographic base*** of the maps in school history atlases should include: hydrography (with names), settlements (at least capital cities and their names), administrative territorial distribution, and cartographic grid. Without these main requirements, cartographic base is considered not optimal and encumbering user's

orientation in the process of communication.

Analysis of cartographic base showed that cartographic base in somewhat more than a half of analysed maps (Fig. 21) is of *medium optimality* (52.4 % of the total of analysed maps). The cartographic base of even in 1/3 (30.4 %) of the maps are *not optimal*. The best variants of cartographic base were found in three school history atlases: about 17 % of the analysed maps have *optimal* cartographic base.

Graphic originality is not used by the majority of compilers (Fig. 22). Graphic originality is *absent* even in about 69 % of the total of analysed school history atlases. *Moderate* graphic originality was determined only in 27 % of the analysed maps and only slightly more than 4 % of maps were marked by *pronounced* graphic originality.

Analysis of the systems of cartographic signs revealed that they are *not* ***standardised*** neither on the international nor national and institutional levels. This circumstance encumbers the readability of cartographic production and assimilation and memorisation of the contained information.

It was determined that the ***readability*** of the majority of maps included in the Lithuanian school history atlases is *good*. These maps account for 64 % of the analysed maps (Fig. 23). *Encumbered* readability is characteristic of more than 34 % and *bad* readability of less than 2 % of the analysed maps.

INVESTIGATION RESULTS OF PERCEPTION OF CARTOGRAPHIC SIGNS IN THE LITHUANIAN SCHOOLS

Perception of cartographic signs according to the data obtained by survey using questionnaires among students

Sociodemographic data about the students/respondents who participated in the survey. During the survey, **536** students of grades 6–12 were interviewed: **216** students of grades 6–8 and **320** students of grades 9–12. The choice of the number of interviewed students was made bearing in mind the actual ratio of students in Lithuanian schools: students of grades 6–8 account for 41 % and 9–12 59 % of the total of students of 6th–12th grades.

Use of legends during map reading. Students not always refer to legends in order to read the information contained in a map (Fig. 24). In the majority of cases (79 % of the total of respondents), students refer to legends only for reading of some of the cartographic signs. About 11 % of students from grades 6–12 say that they understand the cartographic image only using the legends whereas 10 % of students never refer to legends.

Perception of cartographic signs according to the degree of resemblance between the signifier and the denoted object. The present study revealed that students perceive the plotted information best when it is conveyed using imitating/stylised cartographic signs (Fig. 25). This answer was chosen by more than a half of the total of students from grades 6–12. 39.6 % of respondents pointed out that they perceive the information from the maps when it is conveyed using symbolic conventional signs. The information conveyed using abstract conventional signs is perceived with the greatest difficulty. Only about 6 % of respondents pointed out that they most easily understand the maps in which information is conveyed using abstract conventional signs.

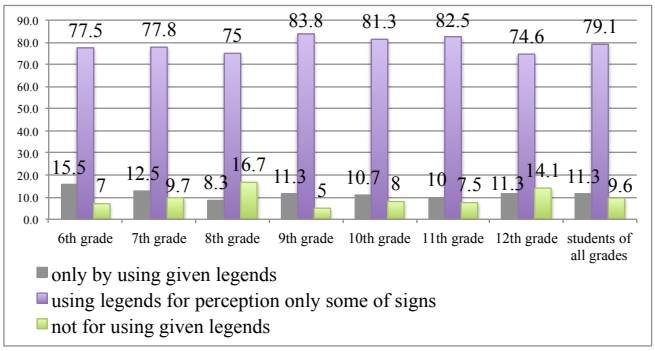


Fig. 24. Usage of maps legends in order to perceive provided information (%)

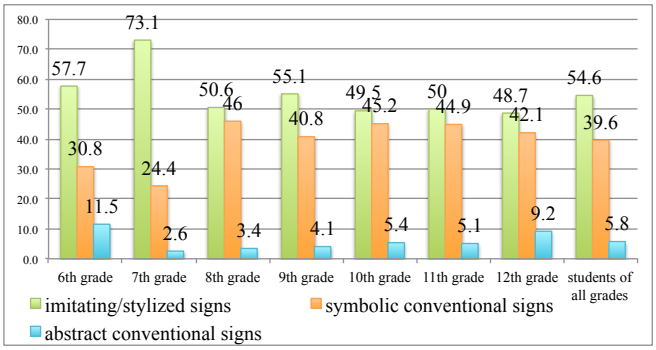


Fig. 25. Perception of information in maps where imitating/stylized, symbolic or abstract conventional signs are used (%)

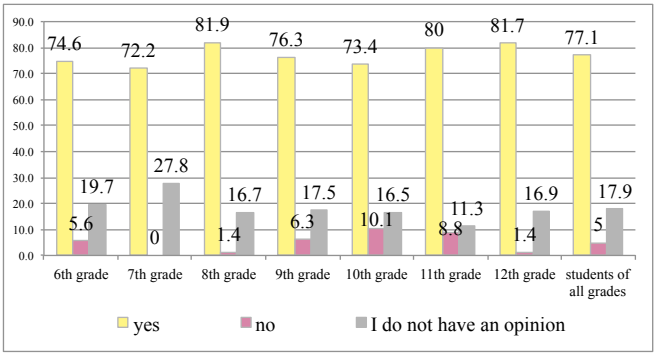


Fig. 26. Students' opinion regarding the standardisation of cartographic signs (%)

Students' opinion about standardisation of cartographic signs. As was already pointed out, sometimes compilers use different cartographic signs for depiction of the same objects. The question whether the systems of cartographic signs should be standardised on the national level was included into the questionnaires. The majority of respondents think that the systems of cartographic signs used in school geography atlases should be standardised (Fig. 26). Even 77 % of respondents supported this opinion. About 18 % of respondents were uncertain and only 5 % thinking that the systems of cartographic signs should not be unified.

Selection of cartographic signs for the table of signs included into the questionnaires. The questionnaires included a table of cartographic signs used by different publishing houses. These signs were divided into six semantic groups: mineral resources, industry, agriculture (sub-groups: stock breeding and plant growing), transport, visiting places (sub-groups: natural and cultural monuments), and natural disasters.

The semantic groups in the questionnaires designed for students of grades 6–8 and 9–12 were the same but with different number of signs. The systems of signs were mainly predominated by symbolic conventional signs (illustrative symbols). They accounted for about 2/3 of the total of signs included in the table (in the questionnaires both for grades 6–8 and 9–12) (Fig. 27). Abstract conventional signs were thrice as rare: in the table of signs for grades 6–8 they accounted for 1/5 and in the table of signs for grades 9–12 for 1/4 of the total. The number of imitating/stylised signs was even smaller. In the table designed for junior students they accounted only for 11 % and in the table designed for senior students for 9.6 % of the total of cartographic signs.

When analysing different semantic groups of cartographic signs (Fig. 28), it was observed that the distribution of signs according to associative capacity of form is rather uneven. Symbolic conventional signs are dominant in all semantic groups of signs. The number of abstract conventional signs in different semantic groups is extremely variable and ranges from 3.9 % in the semantic group "industry" of the table designed for junior students to 57.1 % in the semantic group "transport" of the table designed for senior students. The imitating/stylised signs were not included in all semantic groups of signs (they are absent in the semantic groups "valuable minerals", „transport" and "natural disasters").

Analysis of the selected most easily perceived signs revealed that students first of all pay attention to the shape of cartographic signs and only then to the colour. This conclusion was drawn after analysis of the chosen imitating/stylised and abstract conventional signs made by respondents. Analysis of semantic groups in which, for instance, only imitating/stylised signs were used (as in the semantic groups of stock breeding or plant growing) showed that the choice was made based on the shapes (contour) of signs irrespective of their colours.

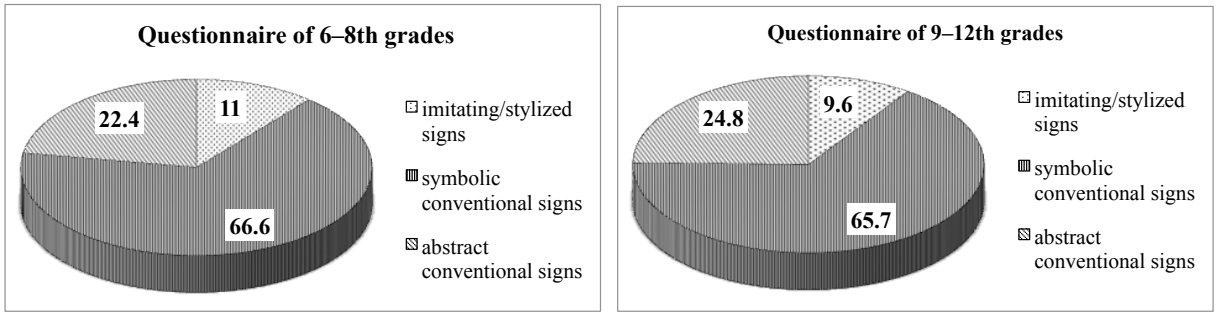


Fig. 27. Distribution of cartographic signs in the questionnaire table according to associative capacity of shape (%)

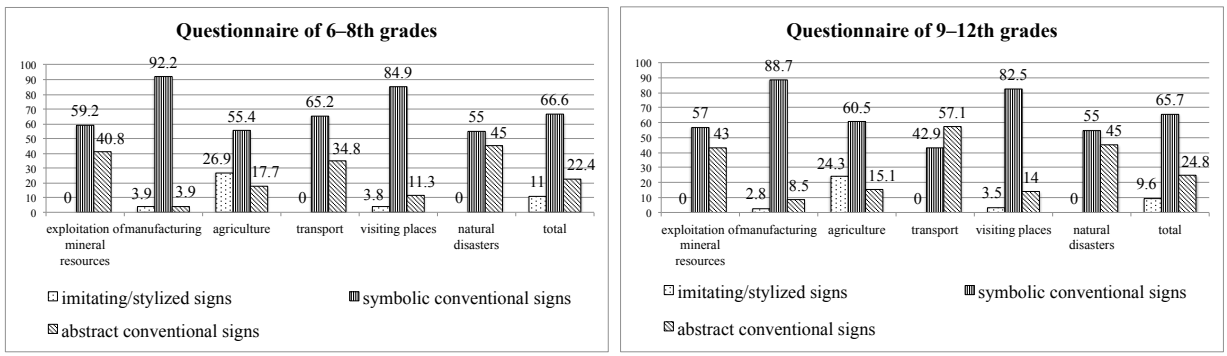


Fig. 28. Distribution of cartographic signs in the questionnaire table according to associative capacity of shape in different semantic groups of signs (%)

The frequency of use of universal atlases and school geography atlases designed for concrete grades. The atlases used in the Lithuanian schools can be grouped into: general geography atlases and school geography atlases designed for concrete grades.

In all surveyed grades, the number of students who used the general geography atlases and school geography atlases designed for concrete grades was comparable (47.9 % and 48.4 % respectively) (Fig. 29). About 4 % of students of grades 6–12 do not use paper geography atlases but prefer online maps which can be found using Google system.

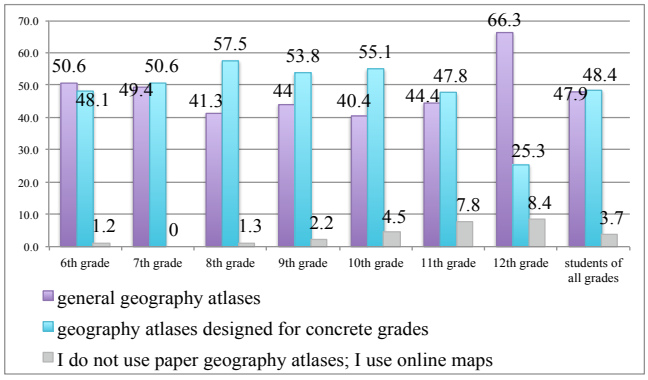


Fig. 29. Most popular geography atlases in the Lithuanian schools (%)

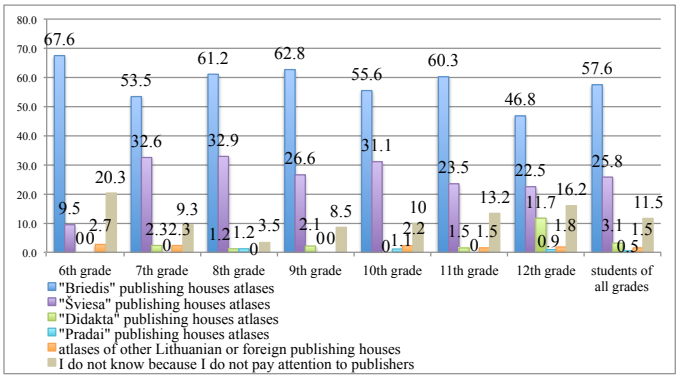


Fig. 30. Distribution of geography atlases used in the Lithuanian schools by publishers (%)

The frequency of use of school geography atlases of different publishers. The study revealed that students most frequently refer to school geography atlases published by "Briedis" publishing house (Fig. 30) (57.6 % of the total number of respondents). They refer most seldom to school geography atlases published by the closed "Pradai" publishing house (hardly 0.5 % of the respondents from grades 6–12).

The frequency of use of universal and school history atlases designed for concrete grades and history atlases supplemented with vocabularies, conspectus and other additional material. As distinct from geography atlases, atlases of history are divided into three groups: atlases designed for concrete grades, universal atlases of history and history atlases supplemented with vocabularies, conspectus and other additional material.

In the majority of cases, students use history atlases designed for concrete grades (about 42 % of respondents) (Fig. 31). Atlases supplemented with additional material are used most seldom (16.5 % of students from gradess 6–12). 6 % of respondents never use paper atlases and prefer online maps found using Google system.

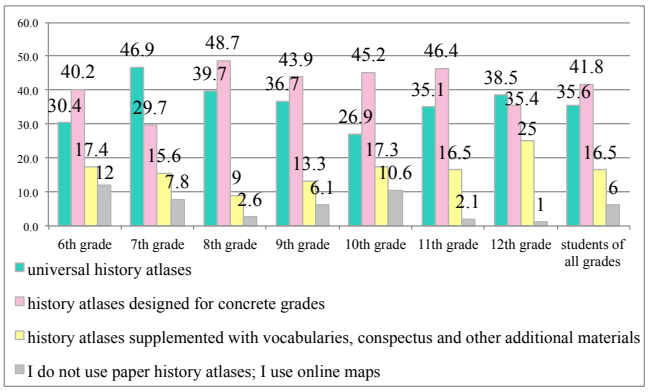


Fig. 31. Most popular history atlases in the Lithuanian schools (%)

The frequency of use of school history atlases of different publishers. The most frequently used history atlases are the ones published by "Briedis" (Fig. 32) (about half of the respondents from grades 6–12; 48 %). Twice as seldom are used history atlases published by "Šviesa" publishing house (about 22 % of the total). About 7 % of respondents use atlases published by "Vaga". The history atlases published by "Naujoji Rosma" are used only by students of grades 9 and 11 (1.3 and 3.2 % respectively). (This publishing house was not included in the questionnaires for grades 6 because its production is designed for senior students). Even about 21 % of students from grades 6–12 do not know the publishers of the atlases they use.

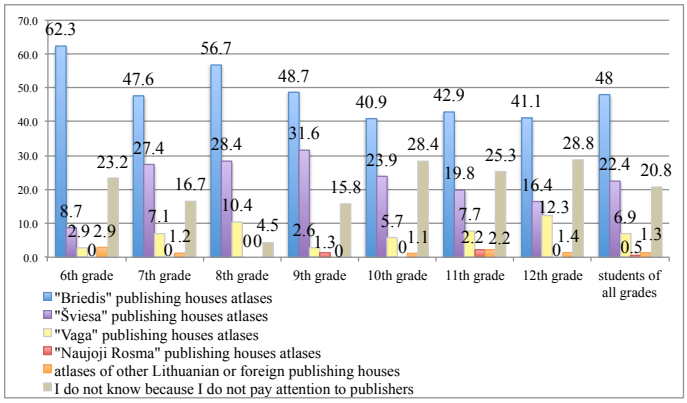


Fig. 32. Distribution of history atlases used in the Lithuanian schools by publishers (%)

Perception of cartographic signs according to the data obtained by survey using questionnaires among teachers

Sociodemographic data about the teachers who participated in the survey. The number of interviewed teachers was considerably smaller than calculated by V. I. Paniotto's formula (Paniotto, Maksimenko, 2003, Kardelis, 2007; Bitinas, 1974). The questionnaires were filled by **127** teachers of *geography* (from 60 Lithuanian towns, boroughs and villages) and **49** teachers of *history* (from 25 Lithuanian towns, boroughs and villages). The reduced number of respondents was predetermined by difficulties in persuading teachers to fill the electronic questionnaires. Lately, the electronic questionnaires have gained popularity. Requests for filling questionnaires on various subjects arrive almost every day and in the majority of cases are ignored. Moreover, many teachers lack skills or have no opportunities to work using modern technologies.

The use of school atlases at lessons. In the teaching/learning process not only textbooks but also variable supplementary teaching aids (exercise books, manuals, and wall, table, line etc. maps, globes and, of course, atlases are used.

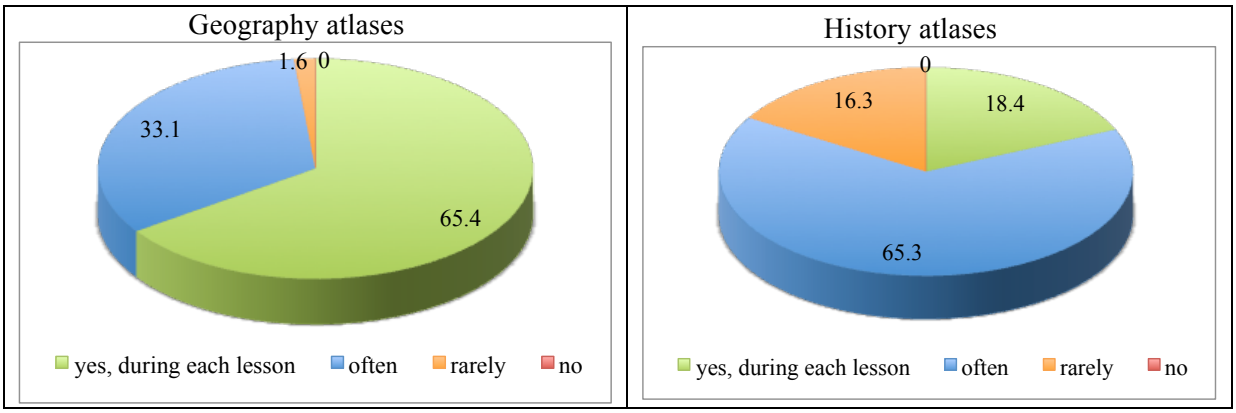


Fig. 33. Frequency of use of school atlases at geography and history lessons (%)

During geography and history lessons, atlases not always are used as a supplementary illustrative material (Fig. 33). At every lesson atlases are used by slightly more than 65 % of geography teachers and even thrice fewer history teachers (hardly 18.4 %). Often this teaching aid is used by 1/3 of teachers of geography and 2/3 of teachers of history. 1.6 % of teachers of geography and even ten times as many teachers of history (16.3 %) point out that they seldom use atlases as illustrative material at their lessons. Yet not a single respondent argued the importance of school geography and history atlases in the learning process.

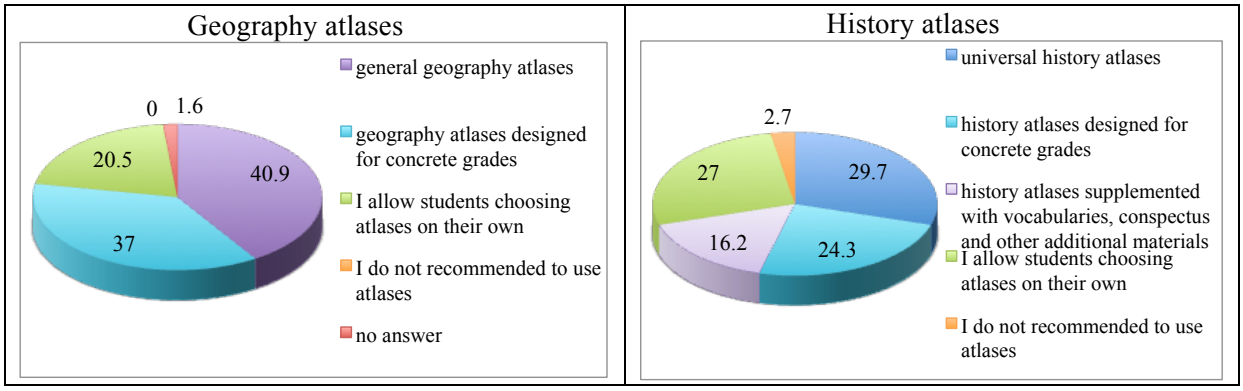


Fig. 34. Types of school atlases recommended by teachers (%)

Geography and history teachers' recommendations as to the use of atlases of different types. Teachers of geography usually recommend to use universal geography atlases or atlases designed for concrete grades (these answers were chosen by 40.9 % and 37 % of respondents respectively) (Fig. 34). Even one fifth of teachers allow their students to choose atlases on their own. There was not a single teacher who would not recommend using geography atlases.

Teachers of history recommend to use universal history atlases (29.7 % of respondents) (Fig. 34). Many teachers (27 %) allow their students to decide on their own what atlas to use. About one fourth of respondents had an opinion that students should use atlases of history designed for concrete grades. 16 % of teachers think that atlases with supplementary material are the best. As distinct from teachers of geography teachers of history not always recommend using school history atlases. 2.7 % of respondents do not recommend using atlases.

Geography and history teachers' recommendations as to the use of atlases of different publishers. The percentage of recommended atlases is predetermined by the different supply of production by different publishers.

Obviously, the most popular among the atlases recommended by geography teachers are the ones published by "Briedis" (even 63 % of respondents chose this variant) (Fig. 35). Respondents seldom recommend using atlases of other publishers. About 8 % of respondents believe that the best atlases are the ones published by "Didaktika", only 2.5 % think that the best atlases are published by "Šviesa" and less than 1 % that the best atlases are published by "Pradai" publishing house. About one fourth of respondents allow their students to decide as to the best publisher on their own.

The situation with recommendations of teachers of history is similar (Fig. 35). More than a half of respondents (about 57 %) recommend choosing school history atlases published by "Briedis". Among teachers of history cartographic production of "Šviesa" is slightly more popular than among teachers of geography: about 10 % of history teachers recommend using maps of this publisher. 2 % of respondents recommend the production by "Vaga" publishing house. More than one fourth of respondents allow their students choosing atlases of different publishers on their own.

Factors which predetermine the choice of cartographic production of different publishers. The choice of school geography and history atlases is not random. It depends on many factors such as: compatibility with the textbooks, i.e. sets of textbooks include a few compatible publications – the textbook itself, teacher's manual and supplementary teaching aids (e.g. exercise books, atlases, reference books, etc. E.g. publishing house "Briedis" releases a series of geography textbooks "Earth" and history textbooks "Time"; "Šviesa" publishers release a series of geography textbooks "Dance" and history textbooks "In the homeland and in the world", etc.). The choice also depends on the quality and price of cartographic production.

Both geography and history teachers point out that their choice usually is predetermined by the degree of compatibility of cartographic production with textbooks (Fig. 36). This response was chosen by two thirds of teachers of geography and more than a half of teachers of history. The quality of cartographic production also was pointed out as playing a role if less important (18 % of teachers of geography and 22 % of teachers of history). About 10 % of history teachers and 5.5 % of geography teachers emphasise the importance of price. 1.6 % of teachers of history and 2 % of teachers of geography pointed out that the least role in the choice of cartographic production is played by promotion.

The capacity of school geography and history atlases, circulating in the Lithuanian market, to answer the students' demands. It was determined that the majority of respondents believe that school geography and history atlases meet the students' demand (Fig. 37). This opinion was expressed even by 85 % of teachers of geography and about 82 % of teachers of history. Yet about 13 % of geographers and more than 8 % of historians have opposite opinion. 1.6 % of geography teachers and more than 8 % of history teachers had no answer.

Teachers' opinion about standardisation of cartographic signs. The study showed that school geography and history teachers would welcome standardisation of cartographic signs in school geography and history atlases on a national level (Fig. 38). About 90 % of geography teachers and about 80 % of history teachers spoke for standardisation of cartographic signs (Fig. 38). The opposite position was taken by 3 %

of geography and 6 % of history teachers. About 5 % of geographers and 10 % of historians had no opinion.

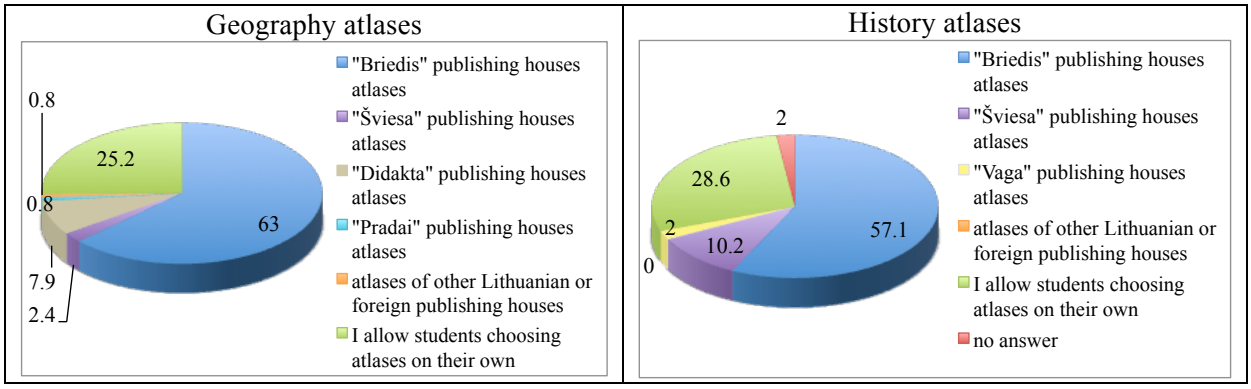


Fig. 35. Publishers of cartographic production recommended by teachers (%)

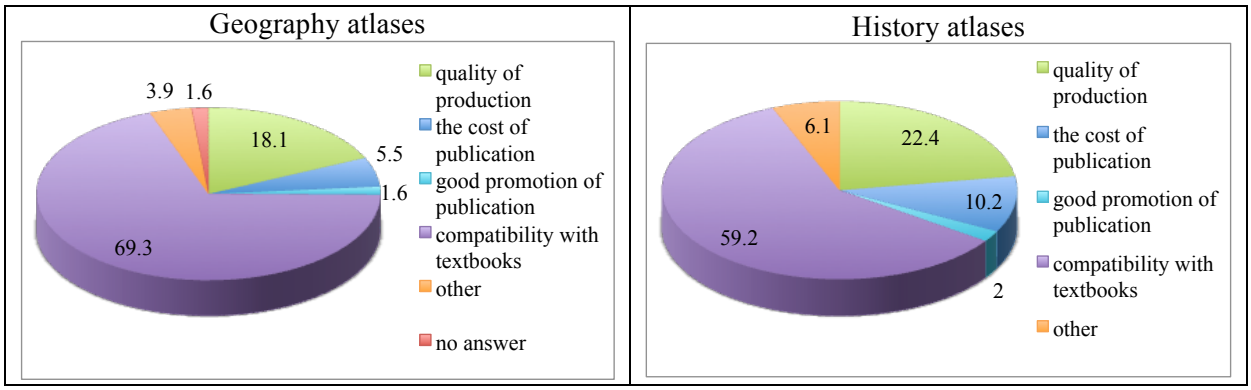


Fig. 36. Factors predetermining the choice of school atlases (%)

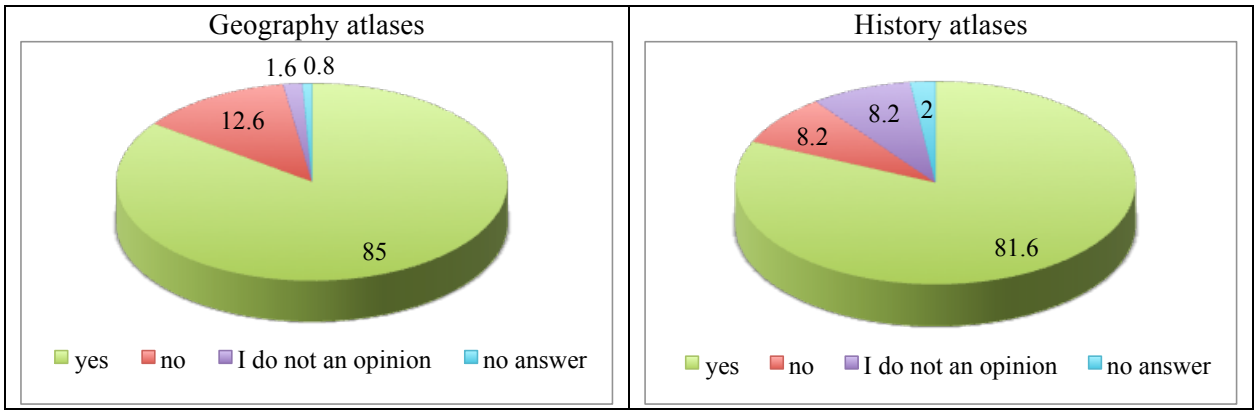


Fig. 37. Capacity of school atlases circulating in the Lithuanian market to meet the students' demands (%)

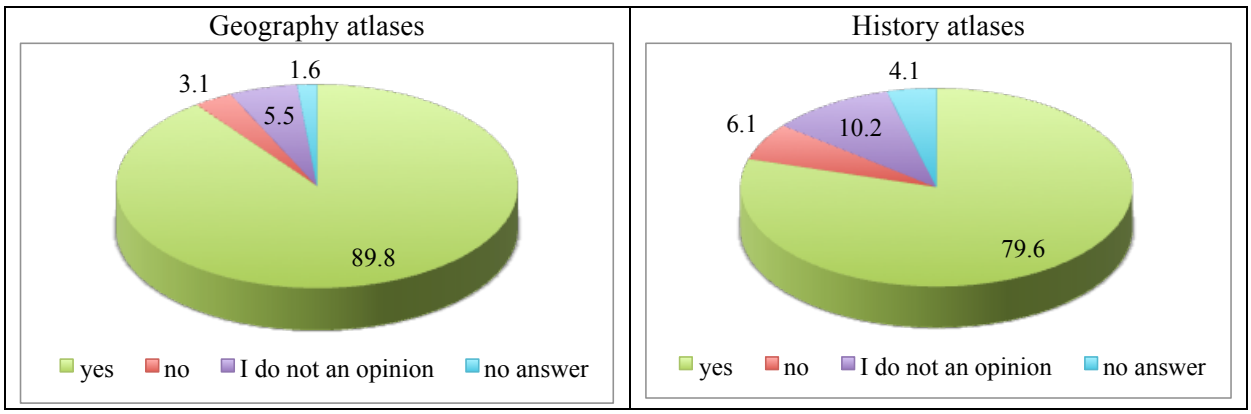


Fig. 38. Teachers' opinion about standardisation of cartographic signs (%)

The use of cartographic sigs in atlases for different grades according to the degree of resemblance with the denoted objects. The majority of geography teachers believe that symbolic conventional signs should prevail in the school atlases designed for students of grades 6–12 (Fig. 39). In the maps designed for students of grades 6, 7 and 8, the imitating/stylised signs should be used at medium frequency. In the maps for senior classes, their amount should be reduced considerably. Most of the teachers pointed out that maps for grades 9–12 should include greater numbers of abstract conventional signs which are more unwelcome by younger students.

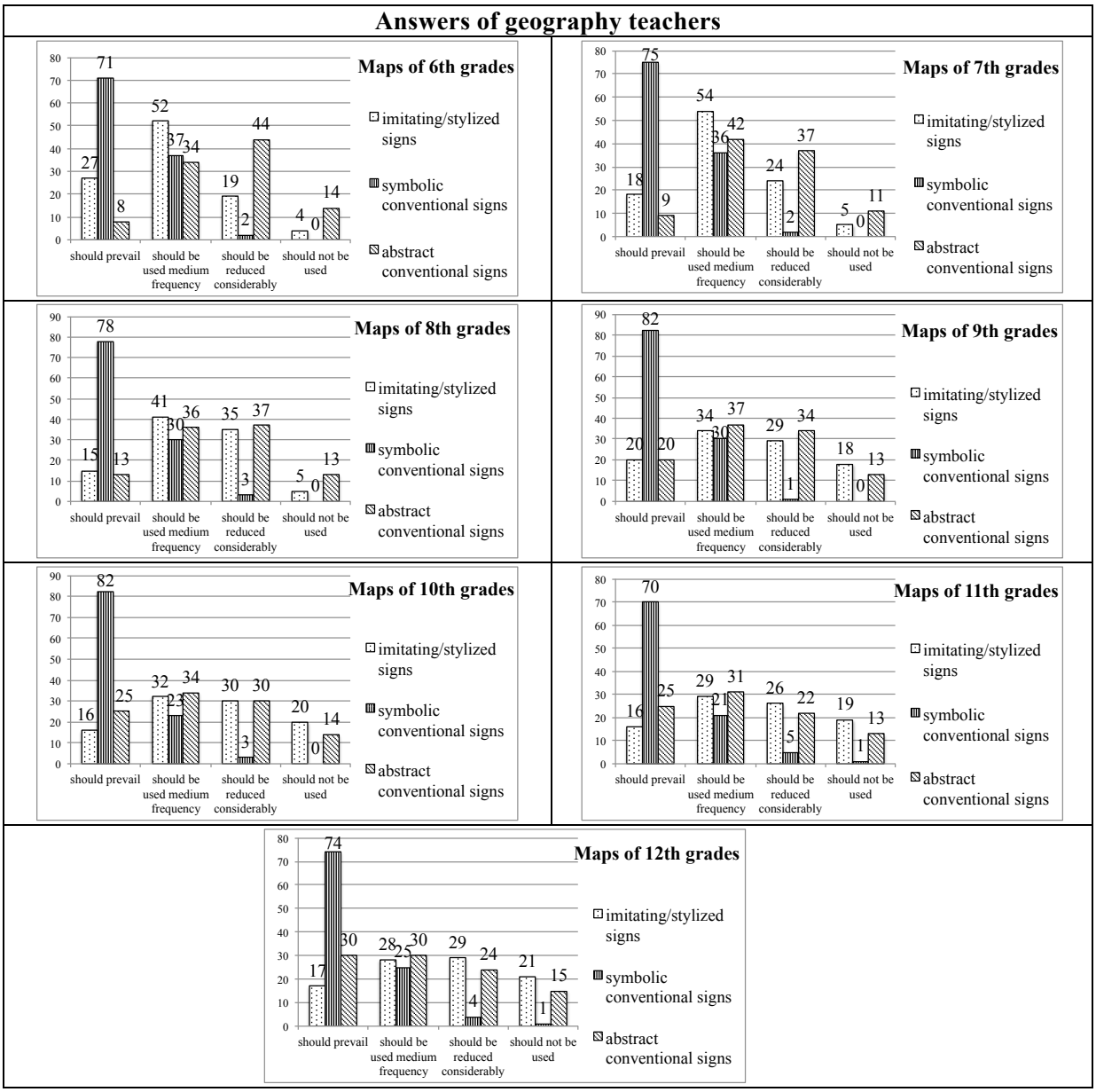


Fig. 39. Use of imitating/stylised, symbolic and abstract conventional signs in the maps of school geography atlases designed for different grades

Teachers of history adhere to the opinion that symbolic conventional signs should prevail in school history atlases (except in atlases designed for grade 6 where, according to equal numbers of geography and history teachers, the imitating/stylised and symbolic conventional signs should prevail) (Fig. 40). A greater number of teachers expressed the opinion that imitating/stylised cartographic signs should be used along with symbolic

ones in the atlases designed for younger students and more symbolic conventional signs at the expense of imitating/stylised signs should be used in the atlases for senior students.

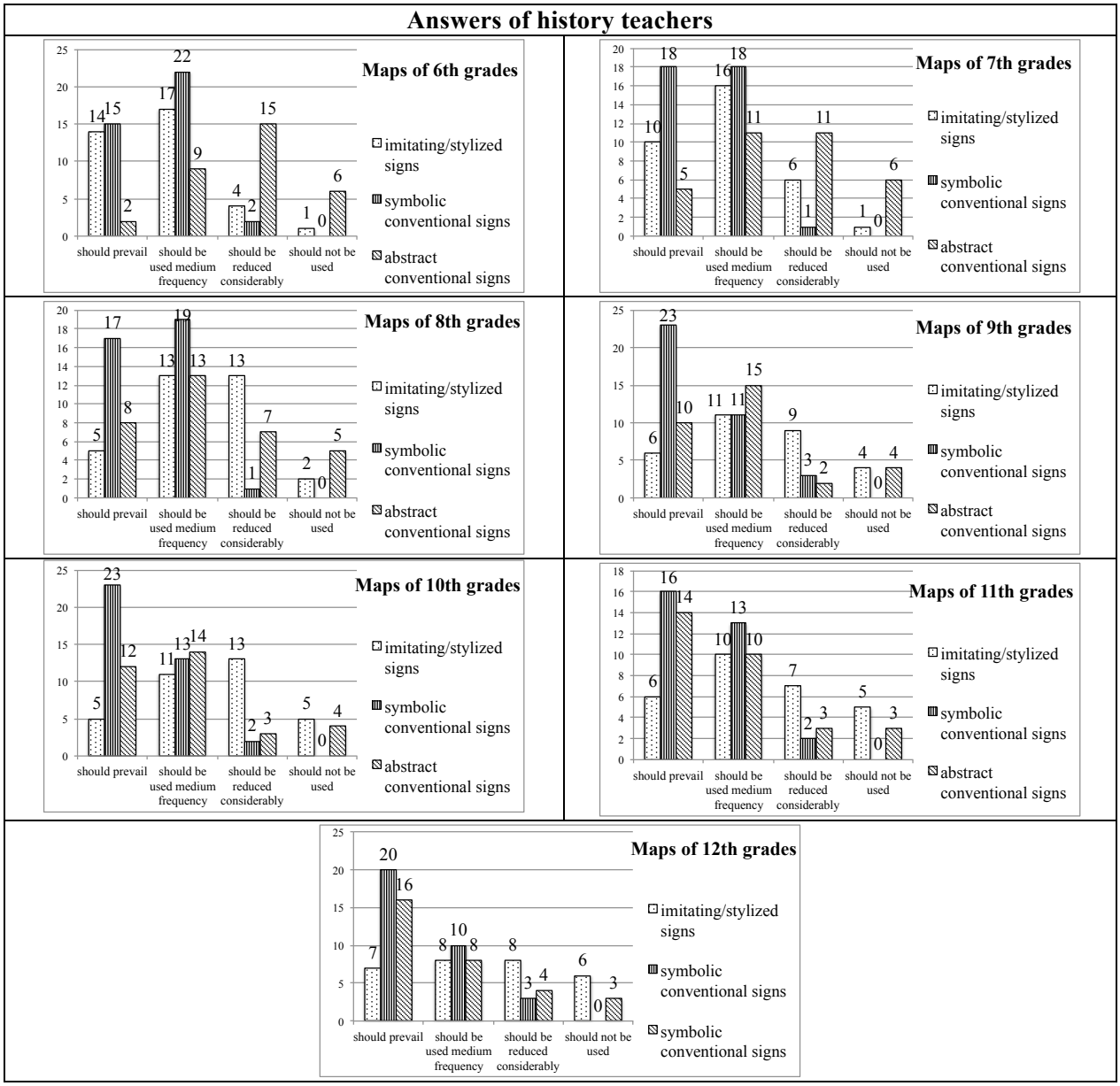


Fig. 40. Use of imitating/stylised, symbolic and abstract conventional signs in the maps of school history atlases designed for different grades

CONCLUSIONS

The survey of scientific literary sources dealing with the subject matter of the present dissertation led to the following conclusions:

1. The problem of standardisation of cartographic signs in school maps of geography and history atlases receives little attention in this country and abroad in spite of the relevance of this issue for cartographic science and improvement of cartographic production.
2. Semantic analysis of cartographic signs showed that in school maps the resemblance of the shape of cartographic signs with the denoted objects commonly is conveyed using symbolic conventional signs. The imitating/stylised

cartographic signs are used most seldom. The signs usually are of symbolic colours.

3. Syntactic analysis of cartographic signs made it obvious that too little attention is paid to disclosure of relationships of real objects, i.e. the semantic groups are distinguished yet seldom titled; the hierarchic relationships are not underlined; the transitive expression if often absent.
4. Pragmatic analysis showed that maps are not overloaded with graphic elements, the volume of information does not increase with the increasing age of the students (in some cases, it even decreases). The cartographic base often is not optimal, graphic originality is lacking and readability of maps is encumbered.
5. The absolute unification of cartographic signs in all maps of school atlases is impossible if only in the maps of the same themes. Unification in history maps is possible only with regard to some groups of signs recurring in many maps.
6. Standardisation of cartographic signs should be conducted taking into consideration the semiotic rules and principles of psycho visual perception and using the key graphic tools – shape and colour of signs.
7. For improvement of communicative quality of educational cartographic production the best use of lettering options – font, style and colour – should be made.
8. Students of grades 6–8 perceive the cartographic information easiest when the average number of bytes per square centimetre of map does not exceed 1600. For students of grades 8–12, the number of bytes should not exceed 2000. A full-scale analysis of optimal graphic load in maps requires further investigation thus the presented results can be regarded only as preliminary ones.

RECOMMENDATIONS FOR IMPROVEMENT OF THE SYSTEMS OF CARTOGRAPHIC SIGNS (USED IN EDUCATIONAL GEOGRAPHY AND HISTORY ATLASES)

Development of the systems of cartographic signs for school geography and history atlases seeking better readability of cartographic products and their more effective perception and memorisation the following recommendations could be helpful:

1. To distinguish correct groups of signs, reveal properly the relationships of cartographic signs in legends and, when possible, to use transitive expression and optimal cartographic base.
2. Taking into consideration the scale and graphic load of maps, to put the point signs within geometrical figures of different shapes. The point signs also should be classified into clearly distinguishable semantic groups. For example, letters (from Mendeleev's periodic table) for ores of ferrous metals could be written in circles and letters for ores of non-ferrous metals could be written in ovals.
3. The cartographic signs with the same meaning but from different semantic groups should be of the same colour conveying supplementary information without using new graphic elements. For example, blue colour could link cartographic signs for metal processing, auto making industry, ship building, etc. and mining of ferrous metals.
4. For optimisation of informational load in the maps of geography atlases for students of grades 8–12, the composition of industry could be plotted using structural circular sign the different sectors of which could be coloured according

to branches of industry (Table 17). The sub-branches could be depicted by shading.

5. In the physical geography, vegetation cover, land use and economic maps, the relief as an element of cartographic base cloud be depicted using shading plastics.
6. The system of cartographic signs given in the first pages of history atlases should be supplemented with a table of names of certain colours for the countries (Table 18). These colours should be adhered to in all maps of the same atlas.
7. The colours used for countries should also be used to depict events related with these countries.
8. The system of cartographic signs given in the first pages of history atlases should be supplemented with a table of names of certain colours for the Baltic tribes (Table 19), which would be taken into account all atlas maps.

Table 17. The individually chosen colours to be used for depiction of branches of industry recommended by the author

INDUSTRY	SUGGESTED COLOR	CMYK CODE	INDUSTRY	SUGGESTED COLOR	CMYK CODE
Energetics		0 50 0 0	Chemical industry		36 72 0 0
Fuel industry		30 0 100 73	Forest, wood processing and pulp – paper industry		100 0 100 0
Ferrous metallurgy (black metallurgy)		0 100 80 65	Building materials industry		0 14 33 18
Non-ferrous metallurgy (colored metallurgy)		0 50 90 0	Light industry		60 0 20 20
Mechanical engineering and metalworking		0 100 100 0	Food industry		0 0 60 0

Table 18. The individually chosen colours to be used in school history atlases for depiction of European states (a fragment of a table) recommended by the author

			States							
No.	**Title of the atlas**	**Title of the map**	**Denmark**	**France**	**Italy**	**Netherlands**	**Portugal**	**Russia**	**Spain**	**United Kingdom**
1.	Universal Historical Atlas for Schools (2004), "Šviesa"	Great geographical discoveries								
2.	In motherland and world. Historical Atlas for the 7–8th grades (2009), "Šviesa"	Great geographical discoveries. Beginning of colonization								
3.	The Middle Ages Historical Atlas for the 8th grade (year of publication is not indicated), "Briedis"	Great geographical discoveries								
4.	Mid modern Period Historical Atlas for the 9th grade (year of publication is not indicated), "Briedis"	World before 1914								
5.	Contemporary Period Historical Atlas for the 10th grade (year of publication is not indicated), "Briedis"	Africa in 1945-1955								
6.	Mid modern Ages. Atlas. Conspectus. Vocabulary (2010), "Briedis"	The world after the First World War in the years 1918-1939.								
National Geographic Atlas of the World			Brown	Blue violet	Yellow	Orange	Green	Pink	Orange	Pink
New York Times Atlas Of The World			Saddle brown	Blue violet	Green yellow	Orange	Green yellow	Orange	Yellow	Pink
SUGGESTED COLOR			**Green**	**Blue violet**	**Yellow**	**Olive drab**	**Green yellow**	**Orange red**	**Orange**	**Green**

Table 19. The individually chosen colours to be used in school history atlases for depiction of Baltic tribes (a fragment of a table) recommended by the author

			Tribes										
No.	**Title of the atlas**	**Title of the map**	**Prussians**	**Galindians**	**Yotvingians**	**Skalvians**	**Curonians**	**Semigallians**	**Selonians**	**Samogitians**	**Aukštaitians**	**Lithuanians**	**Latgalians**
1.	Historical Atlas of Lithuania (2001), "Vaga"	Baltic tribes in the 6th- 7th century											
2.		Confederation of Lithuanian lands in the 13th century in the 2nd decade											
3.	Historical Atlas of Lithuania (year of publication is not indicated), "Briedis"	Baltic tribes in the 15th century											
SUGGESTED COLOR			**Blue**	**Grey**	**Khaki**	**Turquoise**	**Blue violet**	**Light brown**	**Olive drab**	**Dark green**	**Green**	**Green yellow**	**Brown**

Based on the data about the signs most easily perceived by or unacceptable for students of grades 8–12 and following the semiotic rules for compilation of sign systems and principles of psychovisual perception, systems of cartographic signs were developed which after an experimental trial could be suggested as a standard (Table 20; 21). These sign systems were developed using new and existing cartographic signs after correction of their form and/or colour. Regulation of the size of signs is not recommended as it depends on the scales of maps.

Table 20. The recommended cartographic signs for school geography atlases (a fragment of a table)

NO.		MEANING OF THE SIGNS	SUGGESTED SIGN	NO.	MEANING OF THE SIGNS	SUGGESTED SIGN
Exploitation of mineral resources				**Transport**		
1.	Fuel	Petroleum		12.	Seaport	
2.		Gas		13.	Oil pipelines	
3.		Coal		**Agriculture**		
4.	Ferrous metal ores	Iron ore	Fe	***Plant growing***		
5.		Chromium ore	Cr	14.	Cotton	
6.	Non-ferrous metal ores	Aluminum	Al	15.	Bananas	
7.		Lead	Pb	***Stock breeding***		
Heavy industry				16.	Cattle	
8		Metal processing		17.	Pigs	
9		Oil refening		**Visiting places**		
Food industry				***Natural monuments***		
10.		Fish products		18.	Stone	
11.		Bread and confectionery		19.	Tree	

Table 21. The recommended cartographic signs for school history atlases (a fragment of a table)

NO.	MEANING OF THE SIGNS	SUGGESTED SIGN	NO.	MEANING OF THE SIGNS	SUGGESTED SIGN
Science centers			**Conflicts, truce, torturing and the places of torture and killings**		
1.	University, Institute		6.	Uprising in the land	
2.	Gymnasium		7.	Battle location	
Cultural centers				Declaration of independence	
3.	Library		**Religious centers**		
4.	Theater		8.	Diocese Centre of Catholic	
5.	Museum		9.	Diocese Centre of Orthodox	

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Žalalienė I. (2013). Kartografinių ženklų sistemų standartizacija Lietuvos mokyklinėje kartografijoje. Nacionalinė mokslinė konferencija „Geografija: mokykla, studijos, mokslas“, lapkričio 23 d., 2012, Vilnius, Lietuva.

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Ročiūtė I. Dumbliauskienė M. (2011). Analysis of perception of cartographic sign systems in Lithuanian geography atlases for school. International Cartographic Conference, July 3-8, 2011, Paris, France.

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SANTRAUKA

ĮVADAS

Tiriama problema ir temos aktualumas

Įvairūs kartografiniai kūriniai, tarp jų ir žemėlapiai, jau daugelį amžių žmonių naudojami kaip informacijos kaupimo, saugojimo ir perdavimo priemonė. Pirmieji žmonijos kartografiniai darbai (raižiniai urvuose) vargiai primena dabartinius, tačiau jų paskirtis buvo tokia pati kaip ir šiais laikais – perduoti informaciją. Todėl drąsiai galima teigti, kad žemėlapiai turi itin senas komunikacines tradicijas, senesnes ir už rašto. Šių dienų žmogui kartografiniai kūriniai yra itin svarbūs. Juose įvairiais ženklais yra užkoduojama daug informacijos, be kurios sunku apsieiti kasdieniame gyvenime. Žemėlapiai ir kiti kartografiniai produktai kasdien yra naudojami įvairaus amžiaus ir išsilavinimo žmonių skirtingiems darbams atlikti ir siekiant gauti tam tikrų žinių. Taigi norint perskaityti, suvokti ir įsisavinti kartografiniame kūrinyje užkoduotą informaciją, būtina mokėti kartografinę kalbą, kuri neretai yra laikoma ketvirtąja kalba po žodinės, rašytinės ir skaičių kalbos. Ypač svarbu, jog kartografinis raštingumas būtų tinkamai ugdomas jau mokykloje. Kartografinės kalbos mokėjimas ir tolimesnis jos vartojimas gyvenime labai priklauso nuo edukacinės kartografinės produkcijos kokybės. Todėl mokykliniuose kartografiniuose kūriniuose informacija turėtų būti pateikiama nesunkiai suprantama ir lengvai įsimenama kartografinių ženklų kalba.

Lietuvos mokiniai turi nemažas kartografinės produkcijos pasirinkimo galimybes, tačiau kartais kyla abejonių dėl šios produkcijos kokybės. Kartografinius kūrinius ne visada sudaro pakankamai kompetencijos ir patirties turintys kartografai. Be to, sumaišties įneša ir moderniosios technologijos, nes jų galimybės yra itin plačios ir sparčiai kasdien tobulėja. Turbūt dėl šios priežasties net ir aukščiausios kvalifikacijos kartografai, mėgindami sukurti ką nors naujo, patrauklaus ir nematyto, ne visada laikosi net elementariausių kartografavimo taisyklių bei principų. Šias problemas padėtų išspręsti mokyklinės kartografinės produkcijos kartografinių ženklų dalinė standartizacija (kitaip dar vadinama suvienodinimu, unifikacija arba reglamentavimu). Dažnai ne tik skirtingi, bet ir tie patys šios produkcijos sudarytojai ir leidėjai skirtinguose žemėlapiuose tiems patiems objektams, reiškiniams ar procesams vaizduoti naudoja skirtingus kartografinius ženklus, o tai itin apsunkina tų ženklų skaitymo, supratimo ir įsiminimo procesą. Dėl šios priežasties mokiniai, naudodamiesi žemėlapiu, kaskart turi naudotis ir to žemėlapio legenda, kad galėtų perskaityti kartografiniame kūrinyje užkoduotą informaciją.

Kartografinių ženklų sistemų standartizacijos problema mokyklinių geografijos ir istorijos atlasų žemėlapiuose tiek užsienyje, tiek Lietuvoje nėra sprendžiama. Todėl šio tyrimo aktualumas kartografijos mokslui yra neabejotinas.

Tyrimo objektas

Disertacinio darbo tyrimo objektu ***plačiąja prasme*** laikomi visi Lietuvos mokyklose naudojami geografijos ir istorijos atlasai. Tyrimo objektas ***siauruja prasme*** – mokykliniuose geografijos ir istorijos atlasuose naudojamos kartografinių ženklų sistemos.

Darbo tikslas ir uždaviniai.

Šio tiriamojo darbo ***bendrasis tikslas*** – prisidėti prie edukacinės kartografinės produkcijos kokybės gerinimo. ***Konkretusis tikslas*** – patobulinti Lietuvos mokyklinių geografijos ir istorijos atlasų žemėlapiuose naudojamų kartografinių ženklų sistemas,

pateikiant rekomendacijas dėl žemėlapių sudarymo ir juose naudojamų ženklų standartizacijos.

Siekiant įgyvendinti išsikeltus darbo tikslus, buvo suformuoti šie ***uždaviniai***:

1. Išanalizuoti užsienyje ir Lietuvoje vykdytus tyrimus disertacinio darbo tema;
2. Atskleisti kartografinių ženklų standartizacijos sampratą, nustatyti kartografinių ženklų sistemų, naudojamų edukacinės paskirties kartografiniuose leidiniuose, standartizacijos valstybiniu lygmeniu galimybes;
3. Atlikti kartografinių ženklų sistemų, naudojamų mokykliniuose geografijos ir istorijos atlasuose, semiotinę analizę;
4. Išaiškinti kartografinių ženklų suvokimo problemas ir ženklų standartizacijos poreikį;
5. Nustatyti grafinės informacijos apkrovos optimalumo ribas mokyklinių atlasų žemėlapiuose;
6. Parengti rekomendacijas dėl kartografinių ženklų mokykliniuose atlasuose tobulinimo ar galimos jų standartizacijos;
7. Sukurti mokykliniuose atlasuose rekomenduojamų naudoti kartografinių ženklų duomenų bazę.

Mokslinis naujumas

- Pirmą kartą Lietuvoje keliamas edukacinių kartografinių leidinių ženklų standartizacijos klausimas;
- Pirmą kartą Lietuvoje atliktas išsamus visų (1996–2011 metais išleistų) šalies mokyklose naudojamų mokyklinių geografijos ir istorijos atlasų žemėlapių semiotinis tyrimas;
- Pirmą kartą Lietuvoje atliktas mokyklinių geografijos ir istorijos atlasų žemėlapių grafinės informacijos apkrovos vertinimas panaudojant kompiuterines technologijas;
- Laikantis semiotikos taisyklių, psichovizualinio suvokimo principų ir remiantis atlikto tyrimo rezultatais, sukurta kartografinių ženklų sistema, galima naudoti mokyklinių geografijos ir istorijos atlasų žemėlapiuose.

Ginamieji teiginiai

1. Atliekant kartografinių ženklų sistemų kokybės analizę tikslinga taikyti kvalimetrinės analizės metodiką, adaptuotą edukacinės paskirties geografijos ir istorijos atlasams.
2. Standartizacijos valstybiniu lygmeniu nebuvimas turi įtakos mokinių kartografinių ženklų ir kartografinio vaizdo suvokimui.
3. Vykdant mokykliniuose atlasuose naudojamų kartografinių ženklų standartizaciją, būtina remtis produkcijos vartotojų poreikiais ir nuomone.
4. Tobulinant ženklų sistemas edukacinės paskirties geografijos ir istorijos atlasuose svarbiausiomis laikytinos šios priemonės: taisyklingas ženklų suskirstymas į semantines grupes, tinkamas kartografinių ženklų tarpusavio ryšių atskleidimas, aiškus pereinamumo raiškos vaizdavimas, optimalių kartografinių pagrindų naudojimas.
5. Mokyklinių geografijos ir istorijos atlasų komunikacinę kokybę itin pagerintų šiame darbe pateikiamos rekomendacinės ženklų sistemos.

Rezultatų aprobacija

Darbo tema publikuoti 5 moksliniai straipsniai, tyrimų rezultatai pristatyti dvejose

tarptautinėse mokslinėse konferencijoje ir dvejose nacionalinėse mokslinėse konferencijose (detalus mokslinių publikacijų bei konferencijų pranešimų sąrašas pateikiamas po išvadų anglų kalba).

Darbo apimtis ir struktūra

Atsižvelgiant į Lietuvos mokslo tarybos 2003 metais priimą nutarimą Nr. VI-4, darbas sudarytas iš šių pagrindinių dalių: įvado, tyrimų apžvalgos, darbo metodologijos, tyrimų rezultatų, išvadų, naudotos literatūros sąrašo bei priedų. Darbe yra 255 paveikslai (diagramos, schemos bei kartoschemos), 28 lentelės, 280 literatūros šaltinių (neskaičiuojant kartografinių leidinių).

IŠVADOS

Apžvelgus mokslinę literatūrą disertacinio darbo tema, atlikus Lietuvos mokyklinių geografijos ir istorijos atlasų semiotinę analizę ir tyrimą mokyklose buvo padarytos šios išvados:

1. Kartografinių ženklų sistemų standartizacijos problema mokyklinių geografijos ir istorijos atlasų žemėlapiuose tiek užsienyje, tiek Lietuvoje nėra sprendžiama, nors tokių tyrimų aktualumas kartografijos mokslui, siekiant gerinti kartografinių kūrinių kokybę, yra ypač svarbus.
2. Kartografinių ženklų analizė semantiniu aspektu atskleidė, kad mokyklinių atlasų žemėlapiuose naudojamų kartografinių ženklų panašumas į žymimuosius formos atžvilgiu dažniausiai perteikiamas simboliniais sutartiniais, rečiausiai – imituojančiais / stilizuotais ženklais, ženklams dažniausiai parenkamos simboliškos spalvos.
3. Kartografinių ženklų analizė sintaktiniu aspektu parodė, kad kuriant ženklus per mažai dėmesio skiriama tikrovėje egzistuojantiems ryšiams atskleisti – semantinės ženklų grupės išskiriamos, bet gana retai įvardijamos, hierarchiniai ryšiai neakcentuojami, nedažnai vaizduojama pereinamumo raiška.
4. Atlikus analizę pragmatiniu aspektu įsitikinta, kad žemėlapiai nėra perkrauti grafiniais elementais, žemėlapių informacinė apimtis nedidėja atsižvelgiant į moksleivių amžių (kai kuriais atvejais netgi mažėja), dažnai naudojami neoptimalūs kartografiniai pagrindai, stokojama grafinio originalumo, apsunkintas žemėlapių skaitomumas.
5. Visiška kartografinių ženklų unifikacija edukacinių atlasų žemėlapiuose nėra galima – geografijos atlasuose įmanoma tik atskirų temų žemėlapiuose, o istorijos atlasuose galima reglamentuoti tik tam tikras ženklų grupes, pasikartojančias daugelyje žemėlapių.
6. Kartografinių ženklų standartizacija turi būti atliekama atsižvelgiant į semiotikos taisykles ir žmogaus psichovizualinio suvokimo principus taikant pagrindines grafines priemones – ženklo formą ir spalvą.
7. Siekiant pagerinti edukacinių kartografinių leidinių komunikacinę kokybę, būtina kuo labiau išnaudoti užrašų reglamentavimo galimybes taikant atitinkamus šriftus, jų dydžius ir spalvas.
8. 6–8 klasių mokiniai lengviausiai suvokia kartografinę informaciją, kai vidutinis baitų skaičius viename kvadratiniame centimetre žemėlapio neviršija 1600 baitų, 9–12 klasių – 2000 baitų. Siekiant išsamiai išnagrinėti optimalios grafinės informacijos apkrovos žemėlapiuose problemą reikėtų atlikti papildomų tyrimų, tad gauti rezultatai vertintini kaip preliminarūs.

REKOMENDACIJOS KARTOGRAFINIŲ ŽENKLŲ SISTEMŲ TOBULINIMUI (EDUKACINIUOSE GEOGRAFIJOS IR ISTORIJOS ATLASUOSE)

Rengiant mokyklinius geografijos ir istorijos atlasus ir sudarant kartografinių ženklų sistemas šių atlasų žemėlapiams, siekiant geresnio kartografinių kūrinių skaitomumo, efektyvesnio jų suvokimo ir lengvesnio įsiminimo, siūloma atsižvelgti į šias rekomendacijas:

1. Išskirti taisyklingas semantines ženklų grupes, tinkamai atskleisti kartografinių ženklų ryšius žemėlapių legendose, kai yra galimybė – vaizduoti pereinamumo raišką, naudoti optimalius kartografinius pagrindus.
2. Atsižvelgiant į žemėlapio mastelį ir grafinę apkrovą, taškinius kartografinius ženklus įrašyti į skirtingų formų geometrines figūras, taip juos suskirstant į atskiras, aiškiai atskiriamas semantines ženklų grupes, pvz., juodųjų metalų rūdos – raidiniai ženklai (pagal D. I. Mendelejevo lentelę), įrašyti į apskritimus, spalvotųjų metalų rūdos – raidiniai ženklai, įrašyti į ovalus ir pan.
3. Skirtingų semantinių ženklų grupių kartografiniams ženklams, susiejant juos tarpusavyje prasminiais ryšiais, naudoti vienodas spalvas, taip suteikiant papildomos informacijos nenaudojant naujų grafinių elementų, pvz., panaudojant mėlyną spalvą tarpusavyje susiejami metalo apdirbimo, automobilių gamybos, laivų statybos ir pan. bei juodųjų metalų rūdų gavybos kartografiniai ženklai.
4. 9–12 klasių mokiniams skirtuose geografijos atlasų ūkio žemėlapiuose, siekiant optimizuoti informacinę apkrovą, pramonės sudėtį pateikti struktūriniu skritulio formos ženklu, skirtingus jo sektorius nuspalvinant atitinkamomis spalvomis (22 lentelė) pagal skirtingas pramonės šakas. Pošakius vaizduoti pasitelkus štrichus.
5. Geografijos atlasų fiziniuose, augalijos, žemėnaudos, ūkio žemėlapiuose reljefą kaip kartografinio pagrindo elementą vaizduoti pasitelkiant šešėlinę plastiką.
6. Istorijos atlasų pradžioje, šalia pagrindinės kartografinių ženklų sistemos, įdėti lentelę su žemėlapiuose dažniausiai vaizduojamų pasaulio valstybių pavadinimais ir joms priskirtomis spalvomis (23 lentelė), kurių būtų paisoma visuose to atlaso žemėlapiuose.
7. Atsižvelgiant į skirtingoms valstybėms žymėti siūlomas naudoti spalvas, tokias pačias spalvas naudoti ir įvykiams, susijusiems su tomis valstybėmis, vaizduoti.
8. Istorijos atlasų pradžioje išspausdinti lentelę su žemėlapiuose dažniausiai vaizduojamų baltų genčių pavadinimais ir joms priskirtomis spalvomis (24 lentelė), kurių būtų paisoma visuose atlaso žemėlapiuose.

22 lentelė. Skirtingoms pramonės šakoms vaizduoti siūlomos spalvos (spalvos parinktos autorės)

PRAMONĖS ŠAKA	SIŪLOMA SPALVA	CMYK KODAS	PRAMONĖS ŠAKA	SIŪLOMA SPALVA	CMYK KODAS
Eenergetika		0 50 0 0	Chemijos pramonė		36 72 0 0
Kuro pramonė		30 0 100 73	Miško, medžio apdirbimo ir celiuliozės – popieriaus pramonė		100 0 100 0
Juodoji metalurgija		0 100 80 65	Statybinių medžiagų pramonė		0 14 33 18
Spalvotoji metalurgija		0 50 90 0	Lengvoji pramonė		60 0 20 20

Mašinų gamyba ir metalų apdirbimas		0 100 100 0	Maisto pramonė		0 0 60 0

23 lentelė. Mokyklinių istorijos atlasų politiniuose žemėlapiuose rekomenduojamos naudoti Europos valstybių spalvos (lentelės fragmentas; spalvos parinktos autorės)

			Valstybės							
Eil. Nr.	**Atlaso pavadinimas**	**Žemėlapio pavadinimas**	**Danija**	**Prancūzija**	**Italija**	**Nyderlandai**	**Portugalija**	**Rusija**	**Ispanija**	**Jungtinė Karalystė**
1.	Visuotinės istorijos atlasas (2004) mokykloms, „Šviesa“	Didieji geografiniai atradimai								
2.	Tėvynėje ir pasaulyje. Istorijos atlasas 7-8 klasėms (2009), „Šviesa“	Didieji geografiniai atradimai. Kolonizacijos pradžia								
3.	Viduramžių istorijos atlasas 8 klasei (leidimo metai nenurodyti), „Briedis“	Geografiniai atradimai								
4.	Naujųjų laikų istorijos atlasas 9 klasei (leidimo metai nenurodyti), „Briedis“	Pasaulis iki 1914 m.								
5.	Naujausiųjų laikų istorija 10 klasei (leidimo metai nenurodyti), „Briedis“	Afrika 1945-1955 m.								
6.	Naujieji laikai. Atlasas Konspektas Žodynas (2010), „Briedis“	Pasaulis po I pasaulinio karo 1918-1939 m.								
National Geographic Atlas of the World			Ruda	Violetinė	Geltona	Oranžinė	žalia	Rožinė	Oranžinė	Rožinė
New York Times Atlas Of The World			Šv. ruda	Violetinė	Šv. žalia	Oranžinė	Šv. žalia	Oranžinė	Geltona	Rožinė
REKOMENDUOJAMA SPALVA			**Žalia**	**Violetinė**	**Geltona**	**Alyvuogių**	**Šviesiai žalia**	**Šviesiai raudona**	**Oranžinė**	**Žalia**

24 lentelė. Mokyklinių istorijos atlasų žemėlapiuose rekomenduojamos naudoti baltų genčių spalvos (lentelės fragmentas; spalvos parinktos autorės)

			Gentys										
Eil. Nr.	**Atlaso pavadinimas**	**Žemėlapio pavadinimas**	**Prūsai**	**Galindai**	**Jotvingiai**	**Skalviai**	**Kuršiai**	**Žiemgaliai**	**Sėliai**	**Žemaičiai**	**Aukštaičiai**	**Lietuviai**	**Latgaliai**
1.	Lietuvos istorijos atlasas (2001), „Vaga“	Baltų gentys VI-VII a.											
2.		Lietuvos žemių konfederacija XIII a. 2-ajame dešimtmetyje											
3.	Lietuvos istorijos atlasas (leidimo metai nenurodyti), „Briedis“	Baltų gentys V a.											
REKOMENDUOJAMA SPALVA			**Mėlyna**	**Pilka**	**Chaki (rusvai žalsva)**	**Turkio**	**Violetinė**	**Šviesiai ruda**	**Alyvuogių**	**Tamsiai žalia**	**Žalia**	**Šviesiai žalia**	**Ruda**

Išnagrinėjus, kurie kartografiniai ženklai 6–12 klasių mokiniams yra lengviausiai

suvokiami, o kurie labiausiai nepriimtini naudoti, taip pat remiantis ženklų sudarymo semiotikos taisyklėmis ir psichovizualinio suvokimo principais, buvo sudarytos kartografinių ženklų sistemos (25 ir 26 lentelės), kurias, eksperimentiniu būdu patikrinus, būtų galima siūlyti kaip etaloną. Šios ženklų sistemos buvo sudarytos sukuriant naujus ir naudojant jau esamus kartografinius ženklus, pakoregavus jų formą ir (arba) spalvą. Nesiūloma reglamentuoti ženklų dydžių, nes jie priklauso nuo žemėlapių mastelio.

25 lentelė. Mokykliniuose geografijos atlasuose rekomenduojami naudoti kartografiniai ženklai (lentelės fragmentas)

Eil. Nr.		ŽENKLO REIKŠMĖ	ŽENKLAS	Eil. Nr.		ŽENKLO REIKŠMĖ	ŽENKLAS
Naudingųjų iškasenų gavyba				**Transportas**			
1.	Kuras	Nafta		12.	Jūrų uostas		
2.		Dujos		13.	Naftotiekis		
3.		Akmens anglis		**Žemės ūkis**			
4.	Juodųjų metalų rūdos	Geležies rūda	Fe	***Augalininkystė***			
5.		Chromo rūda	Cr	14.	Medvilnė		
6.	Spalvotųjų metalų rūdos	Aluminis	Al	15.	Bananai		
7.		Švinas	Pb	***Gyvulininkystė***			
Sunkioji pramonė				16.	Galvijai		
8.	Metalo apdirbimas			17.	Kiaulės		
9.	Naftos perdirbimas			**Lankytinos vietos**			
Maisto pramonė				***Gamtos paminklai***			
10.	Žuvies produktai			18.	Akmuo		
11.	Duona ir konditerijos gaminiai			19.	Medis		

26 lentelė. Mokykliniuose istorijos atlasuose rekomenduojami naudoti kartografiniai ženklai (lentelės fragmentas)

Eil. Nr.	ŽENKLO REIKŠMĖ	ŽENKLAS	Eil. Nr.	ŽENKLO REIKŠMĖ	ŽENKLAS
Mokslo centrai			**Konfliktai, paliaubos, kankinimo ir žudynių vietos**		
1.	Universitetas, institutas		6.	Sukilimas sausumoje	
2.	Gimnazija		7.	Mūšio vieta	
Kultūros centrai				Nepriklausomybės paskelbimas	
3.	Bibliotekos		**Religiniai centrai**		
4.	Teatras		8.	Katalikų vyskupijos centras	
5.	Muziejus		9.	Stačiatikių vyskupijos centras	

CIRUCULUM VITAE

Vardas, Pavardė	**Inga Žalalienė**
Gimimo data, vieta	1984-03-12, Kretinga, Lietuva.
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Išsilavinimas	
2003 m.	Vidurinis išsilavinimas, Gargždų „Kranto“ vidurinė mokykla.
2007 m.	Geografijos studijų programos bakalauras, Vilniaus universitetas.
2009 m.	Geografijos studijų programos magistras, kartografijos kryptis, Vilniaus universitetas
2009-2013 m.	Geografijos krypties doktorantūros studijos, Vilniaus universitetas.
Moksliniai interesai	Teminė kartografija, kartografinė semiotika, standartizacija.