VILNIUS UNIVERSITY
INSTITUTE OF GEOLOGY AND GEOGRAPHY

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THE ANALYSIS AND EVALUATION OF CARTOGRAPHICAL IMAGES OF EDUCATIONAL DIGITAL AND PAPER MAPS
(On the basis of graphic information load)

Summary of Doctoral Dissertation
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VILNIAUS UNIVERSITETAS
GEOLOGIJOS IR GEOGRAFIJOS INSTITUTAS

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ANALOGINIŲ IR SKAITMENINIŲ EDUKACINIŲ ŽEMĖLAPIŲ KARTOGRAFINIO VAIZDO ANALIZĖ IR VERTINIMAS
(grafinės ir informacinės apkrovos pagrindu)

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INTRODUCTION

Geography is the study of the complex patterns of the changing Earth environment and of the processes that continue to modify our planet. It is concerned with the study of the spatial and temporal inter-relationships of the Earth's human, physical and biophysical environments. It is a fundamental branch of theoretical and practical enquiry covering the Earth's environment, focused particularly upon helping to solve people's practical problems of living in diverse environmental and cultural settings.

Geography is one of the sciences which mostly integrate into many other subjects studied in comprehensive secondary school. It covers a wide range of matters related with the global system: nature–man–society–economy–culture.

Education using computer becomes more popular increasingly apace. Mostly, the term "information technologies" is defined as application of information tools for performing various information-related tasks. There are different information tools that can be used in school. They can be designed for information transmission, storing, processing and etc. When information technologies are used in a lesson, different educational methods as well as the work tone can be co-coordinated. In lessons where information technologies are used mastering of knowledge is more effective because it is an interesting education form for the students (Bevainis, 2006).

In order to get to know the relations between geography and information technologies, the purpose of geography as a discipline in comprehensive schools must be compared with that of information technologies used in geography lessons. The shared purpose of geography and information technologies can be formulated as follows: to provide as much as possible geographic knowledge for the students, for their skills in work with information technologies.

If this purpose would be incorporated in programs of geography and informatics these two disciplines could be integrated effectively. Following information tools are used for teaching geography: computer, educational geographic programs, GIS, and internet (Mackeviciute, 2003).

Geographic information systems (GIS) can help learners of all ages understand the world around them. GIS helps students and teachers engage in studies that promote critical thinking, integrated learning, and multiple intelligences, at any grade level. In classrooms around the world, educators are using GIS in the study of topics as varied as Geography, History and etc.

Research problem and the relevance of the study

Maps are one of the geographer's most important tools, providing useful ways of storing and communicating information about people and places. If geography involves the study of the relationships between people and places, then maps help geographers to present, describe and explain the spatial information, patterns and processes that they observe in the world around them.

During their geographical education students should encounter a wide variety of maps drawn for different purposes and different scales. Geography teachers should help pupils develop and learn how to use the essential map skills. A structured approach involving practice in reading and using a variety of maps can certainly help pupils develop and apply these skills.

Atlases are widely regarded as typifying geography education. They are essential reference tools at home and at school, often represent a sizeable investment of educational recourses and play a key in shaping children's view of the world. These atlases are created by competent cartographers, but yet we know very little about how they are developed or the basis on which their cartographic content is determined.

Geography teachers should help pupils develop and learn how to use the essential map skills. A structured approach involving practice in reading and using a variety of maps can certainly help pupils develop these skills and apply them in different context.

Thematic maps are created considering to special standards and recommendations for cartographic signs, graphic information loads and et cetera (Dumbliauskienė, 2002). However, training maps in Lithuania are still produced without any clear standards or recommendations for the content. There are not enough researchers done on pupils' perception of training maps such as an optimal quantity of graphic information in the maps for pupils for different grades. So, it is necessary to create the recommendations how to draw the geographic maps according to pupils' perception in any grade.

Research object

The object of this research is the analysis and evaluation of cartographical images of training digital and paper maps of school atlases through the assessment of their contents on the basis of graphic and information load.

The aim and objectives of the study

The aim of this work is to execute the calculations of graphic information load of cartographical images for the paper maps and digital maps of educational computer programs created for junior high school pupils. According to the results of the research it is necessary to determine the optimal values of graphic information loads.

The main objectives are:

1. To explore the Lithuanian and foreign countries experience in investigations relating to the use of geographic information systems during geography lessons.
2. To evaluate geographic educational software and to consider their usability for Lithuania schools.
3. To develop a methodology for the calculation of the graphic information loads of the cartographic images of the training maps adopted for junior high school students.
4. To evaluate the optimal values of graphic information loads of training maps adopted for junior high school pupils.
5. In accordance with a created methodology to evaluate and compare the values of graphic information loads of training maps created by the Lithuanian and Japanese publishers of educational school atlases.

Scientific novelty of the study

In education as well as in other areas, visualization is spreading widely as method. It is newly seen the traditional educational process and tools. Map is one of the oldest school attributes as a teaching tool used in many different subjects and curricular areas. However there are no new – especially original – educational researches about the information quality and quantity of the content of the training maps.

In this paper author summarized the experience of applying GIS in geography teaching in Lithuania and Japan schools, also for the first time made very detail surveys on the basis of pupils' perception of cartographic materials as well as provided a new methodic of pupils individual perception of graphic information loads and provided the specific and concrete recommendations of graphic information loads for the creation training maps for different levels of junior high school pupils.

Defensive statements:

1. In modern education the management of information systems through the application of information technologies has become an integral part of the methodological training of geography, enabling students to develop comprehensive competencies in geography.
2. The information technologies applicable to Lithuania geography lessons are an integral part of the geography curriculum, consistent with the existing global standards for information technology in education, but in Lithuania and also in foreign countries leading information management systems, these tools are not fully regulated.
3. The concentric education system is applying in Lithuania educational system which allowing to realize the progressive development of the perception of cartographic works during the geography lessons based on a good quality of students' thinking in progress in different stages of intellectual development, thus it is extremely important that the educational maps also reflect the different amounts of information depending on the user's age.
4. The graphic information load of the training maps of school atlases are not correct and does not meet the students' geographical understanding during the different levels of junior high school.

Approbation of the results

7 scientific articles and and one diploma work have been published on the thesis topic. A detailed list of publications associated with the paper's topic is given below the conclusions of this paper.

Size and structure of the study

This paper consists of the following recommended main parts referring to the Lithuania Science Council's resolution No. VI – 4, 2003: the introduction, the research review, methodology, research results, conclusions and references. The paper includes 91 original pictures, 23 tables and 112 literature sources. The whole paper consists of 213 pages.

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1. RESEARCH REVIEW

The experience of GIS integrating into geography teaching in Japan

The use of geographic information system (GIS) in education in Japan has not yet widely been distributed. It is because that there are few teachers skilled in GIS and the software is expensive (Ida, 2006). In recent years, along the education reform, "the integrated study" program has been launched in all elementary and secondary schools in Japan. At the same time, the computing environments in classroom have been improved. Circumstances for using GIS in schools seem to be almost ready. However, only some motivated teachers have been using GIS for their classes. It's clear that the utilization of GIS in education depends a lot on teachers who decide to use this tool in lessons. To enable more utilization of GIS in education, in-service teachers and students in teacher training in universities or collages need to get not only knowledge of GIS and its method of operation but also facilitation skills to involve students and generate ideas with GIS in classes (Yuda and Itoh, 2006, 2009, Johansson, 2003).

The term "GIS" has been introduced in geography text books for high school since 1995. Therefore a number of experimental lessons with GIS have been reported in recent years (Itoh, 2006). These studies educe that the use of GIS has been growing gradually in mainly geography classes in lower and upper secondary schools in Japan. At the same time these reports indicated the existence of some motivated teachers who know the characteristics of GIS. These teachers have reported their experiences of using this tool in classes of geography, information or integrated study. A handful of teachers are surely using computers including GIS often, whereas GIS has been still out of the mainstream in classes. One of the reasons why GIS has not been distributed in secondary education might be that the National Curriculum Standard has not forced the schools to use GIS in a class. The curriculum just highly recommends using computers and information and telecommunication network. Other problems for using GIS in classes are computer environment, software and data and the quality of teachers.

Now it would not be an exaggeration to say that the use of GIS as a tool for lessons depends on teachers themselves. They should know GIS in some way because they are living with this tool today. Teachers have to get much information interactively with maps freely on the computer. There are many services supported by GIS and teachers can use it without regard to this tool. As Satoru Itoh mentioned that GIS is a popular 'invisible' tool for us today and our daily lives rely on this tool in many aspects. Yet teachers don't adopt that in their classes. One of the reasons why GIS hasn't been accepted widely in education might be that many of the teachers have neither studied it before when they were students nor had experiences to use GIS as an education tool before. Although GIS started to develop in 1960s, it became widely known in 1990s. Coincidentally GIS have been introduced in geography and relevant fields in universities. Therefore, the absolute number of teachers who have studied GIS in university is small. The lack of teachers with GIS literacy can be also explained by the schoolteachers' licensing system. Since geography as a subject belongs to the social studies, people who have studied other disciplines in social sciences or humanities like history, economics, politics or sociology in a university can get a teaching qualification in geography and history in lower and upper secondary school under the existing system. Actually a number of teachers without the learning experiences of geography as a major are teaching geography in schools. It is necessary for the utilization of GIS that users have a geographical way of thinking. The geographical way of thinking helps to read many phenomena from overlapping information on a map and this skill can be acquired through geographical education. From this point of view, it can be said that for these kinds of teachers it must be hard to accept this tool into their lessons.

With the analysis of literature, the researcher found four crucial problems about integrating information technologies and GIS into geography lessons.

The first problem is that the National Curriculum Standard has not forced but just recommends using information technologies and GIS in the lessons. Educators have possibility freely choose the other methods of teaching.

The second problem is because of schoolteachers' licensing system. Students who have studied such disciplines like history, economics, politics or sociology in a university can get a teaching qualification also in geography in lower and upper secondary school. As a result they have not enough competence and skills use geographic computer programs and GIS in their lessons.

The third problem is that geography teachers are very busy and they have not enough time to learn and understand information technologies.

The last big problem is that software is very expensive. Only some private or special schools can by it for using.

Due all these factors, information technologies (especial GIS) haven't considerably penetrated into the geographical education.

The experience of GIS integrating into geography teaching in Lithuania

Since 1994 Information Computer Technologies (especially Geographic Information Systems) are getting more and more popular in Lithuania. Today the biggest part of Lithuanian Governmental institutions (Ministries, State departments, Research Institutes), over 70% of municipalities, utilities (Lithuanian Gas, Lithuanian Energy and other establishments), a lot of privately owned companies have implemented GIS in their work. However, quite a different situation we have in the educational institutions. There GIS technologies are coming very slowly. The universities and high schools have old GIS software and not every lecturer realizes how GIS could be useful for different fields of studies.

GIS is still an obscure thing in Lithuanian schools. In the outline of the national curriculum for upper secondary schools, produced in 2002, GIS is incorporated into the elective, advanced geography course. Pupils get some theoretical knowledge about GIS and digital cartography. However, geography teaching with GIS is still very limited in secondary schools.

Moreover, the laboratory of geography teaching investigations of Vilnius Pedagogical University (VPU) started to implement program of geographical education computerization in 1994. This laboratory has been doing periodical teachers questionings about the situation of geography education computerization in the secondary schools since 1998 (Krupickas et al, 2000).

In the beginning of 21^{st} century, information technologies are integrating into geography learning at school faster. It is necessary because education of geography is developing and requires more methods to get the information, analyze it and prepare the results. The way to integrate information technologies gives a possibility to use (Krupickas, 2004):

1. Internet
2. Geographic computer learning programs
3. GIS

But still there are some problems that prevent to use IT widely in schools:

1) There are no enough computer classes in schools to learn geography using geographic computer learning programs or internet.
2) Only very few teacher can teach pupils using IT, they are not qualified enough.
3) It is still lack of software in Lithuanian language.

There are a lot of geographic computer programs (Fig. 1) but the most popular are "Eye - M", "General geography", "World geographic zones", "Encarta WA" and etc. It is very important that some of these programs have functions of GIS (table 2). There are shown the wide spectrum of GIS abilities in table 1.

Also there is a possibility to developing pupil's self-sufficiency, computer literacy, orientation in nowadays information using geographic computer programs and GIS.

Tabele 1. Training of information ability using GIS

Conception of GIS	Pupils realize GIS functions and use it
Social ethnic and cultural aspects	Pupils learn to use GIS train there attitude to learn all life, collaborate and etc.
GIS use	GIS using for modeling, maps creation, data collection and etc.
Communication tool	Pupils change their information about the new technology with each other and their teachers
Investigation tool	Pupils use GIS to collect information analyze data, investigate results
Control tool	Pupils use GIS to do their tasks, use GIS to formulate strategies and etc.

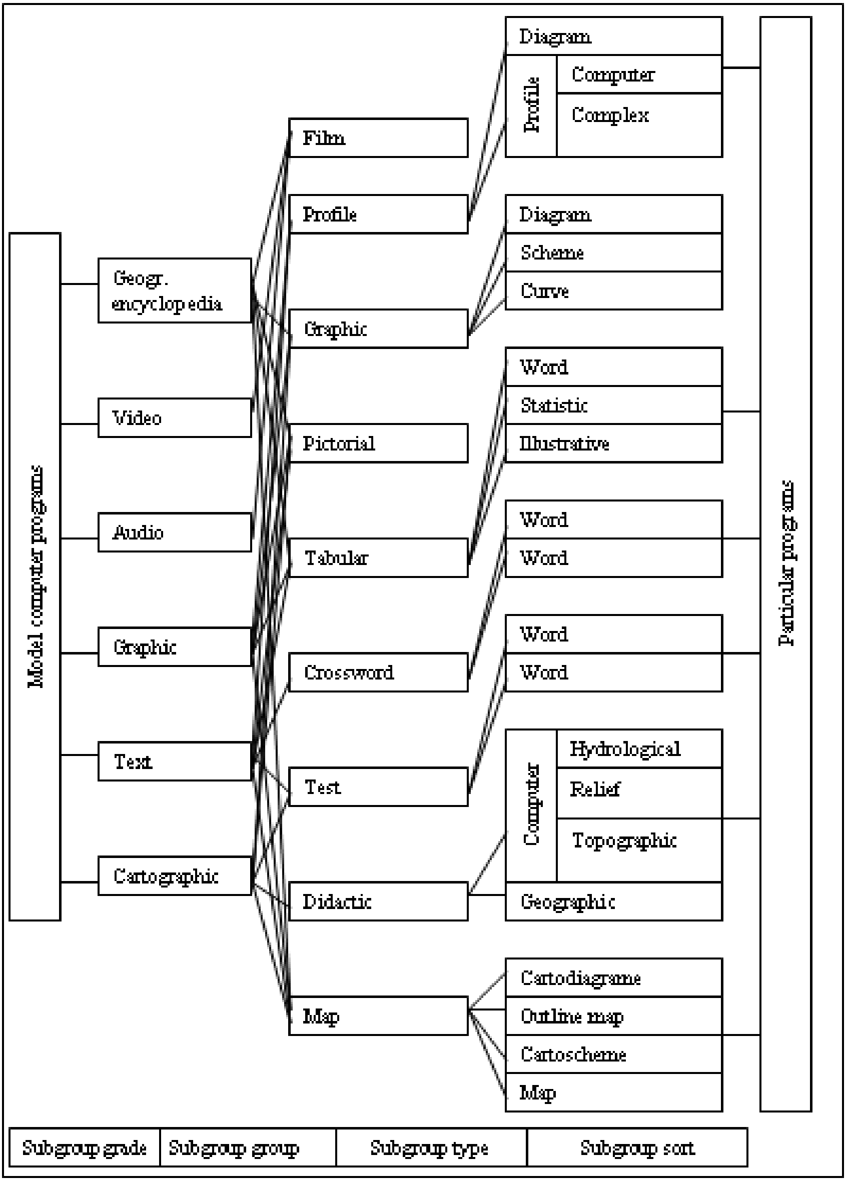

Fig. 1 Classification scheme of geographic computer programs (Krupickas, 2000)

Table 2. Main functions of GIS and possibility to do the same with other programs

Main GIS functions	Programa „Akis-M 2.0“	„www.maps.lt“	Programa “Green Map”	Programa “Global Map”
Measurement (area perimeter, coordinate, azimuth, degree)	Yes	Partly	Yes	Yes
Distance measurement (distance between two points)	Yes	Yes	Yes	Yes
Maps layers and objects	Yes	Partly	Yes	Yes
Data accumulation	Yes	Partly	Partly	Yes
Objects search	Yes	Yes	Yes	Yes
Different areas selection and work with them (classification, area count)	No	No	No	Yes
Thematic maps creation from topographical maps	No	No	No	Yes
New maps layers creation	Yes	No	No	No
Possibility to work with different digital maps of Lithuania and other countries	Partly	No	Partly	No
Change of maps position (Zoom in/out, cut and etc.)	Yes	Yes	Yes	yes
Possibility to print of all data	Yes	Yes	Yes	Yes

2. METHODOLOGY

This work was done according to the results of the experimental researches in the secondary schools in Japan and Lithuania. It was done 4 researches at all.

The first pedagogical research which was executed in Japan is related to GIS integrating in all junior high school levels.

The design of the research. This study intended to find out the real ways how Japanese geography teachers integrating Geographical Information System, into geography lessons in junior high schools in Japan. The data collection was done through:

1. Actual observation of geography classes in junior high schools in Japan.
2. Interview with geography teachers about the usage of Geographical Information System in lower secondary schools in Japan.
3. Questionnaires for Japanese geography teachers about the usage of GIS in junior high schools in Japan.

Lessons observation. There were observed three classes of geography in junior high schools and one in upper secondary school in Japan. The class observation in upper secondary school was done in Komaba School. Two observations were done in Keio

Gijyuku Futsubu junior high school. One more geography class was in Tsukuba Daigaku Fusoku junior high school. These schools are advanced schools in using Information Technologies and cannot be considered as a representative of Information Technologies using in geography lessons in junior high schools in Japan. These schools can be a very strong guide to become aim in order to develop Information Technologies during geography lessons in lower secondary schools in Lithuania. The main purpose of the observation was to observe and study the teaching methods and the ways of integration of Information Technologies in geography teaching to promote pupils geographical skills.

Interview with teachers. The main purpose of the interview was to understand the today's perception of geography teachers about geography teaching in junior high school in Japan and also to discuss about geography teaching focusing on GIS integration into geography classes.

Moreover, the information carried out during the interview also shows the situation of geography teaching in junior high school in Japan in two parts. One part is about teachers' perception of using GIS in teaching. Another one is about the way of using technologies and the results.

Questionnaires. Questionnaires were divided directly to the geography teachers of junior high schools in Ibaraki and Tokyo prefectures. There were 16 turnovers. The period includes preparing, translating, dividing, receiving and checking which was from September 10th to November 22nd.

The content of the questionnaires is concentrate on information technologies, especially GIS, integration into geography teaching in junior high schools.

The second pedagogical experiment was made in Lithuania schools.

The goals of the experiment were:

1. To find out pupils position on computerize geographic learning;
2. To clear up pupils ability to use geographic computer programs (Eye - M 2.0);
3. To find out pupils priority to choose one of the methods to get information.

It is important that we can computerize geography learning in 5 – 12 classes. From 5th till 10th classes the computerizing must be less then 50 percents. In higher classes it can rise till 80 – 90 percents. It was made a pedagogical experiment. Pupils from 6 till 11 classes were participating. The main task of this experiment was to point out pupils' ability to use GIS in the project.

The third cartographical – pedagogical research was accomplished in Lithuania schools, the partiticipants were pupils from VI – X classes.

The aim of this research is to find out about pupils understanding of graphic information loads in the maps and describe the solutions in this way.

The main task of the reseach:

- to identify the optimal graphic information load for the training maps content according to the appropriate classes;
- to analyze and determine the graphic information load in atlas maps which pupils are already using.

In fact the graphic information load in the map is one of the most important things that can influent pupils' skills to read and understand maps (Bevainis, 2008, Rataiski, 1970, Rataiski, 1971, Rataiski, 1976).

The research was divided into two parts.

During the first part of the experimental research pupils were split into three groups according the Basic geography education program point 9.3.3.2:

1. Satisfactory level of achievement.
2. Basic level of achievement.
3. Higher levels of achievement.

According to Piaget's theory, students' level of understanding of the content of the map can have a direct correlation between the levels of general intelligence. It is estimated that the pupils' different levels of intelligence usually differ. Dividing students into three types, there is greater opportunity more precisely identify the graphic information load on the map to appropriate level for different age groups (table 3).

At the same time, the study involved only part of the class of students (10 students), while the remaining students did lessons with other subject-related tasks. It has been awarded individual tasks. Map fragment was shown on the wide screen for participating students. Also, one paper copy of the map the same students received personally. Task completion time was recorded for each student individually, as the study included achievement of different groups of students.

The students received simple tasks, but framed in such a way that they should be based on spatial thinking and analysis in determining the content of the map legend.

Tasks raised the following main conditions:

1. Analyzing the contents of the map mentally split it into layers of graphic data.
2. Recognize and differentiate the characters according to categories.
3. To find specific objects.
4. Indicate their location on the map.

Examples of tasks that were carried out in different outcomes in different groups and classes of students:

- Find and list the gravel, which belongs to districts of Radviliskis, Kelme. Listed the items according to the district council.
- Find and list all the natural and geological monuments in Raseiniai, Kelme and Rietavas regions. Grouped by district municipalities.
- Find a map of the river Musa and the inflows in Joniskis, Pakruojis regions. Listed the items according to the district council.

Pupil reaction to the content of map and end time of task helped to identify in which fragment graphic information load is correct for the student's understanding of a particular class level.

There were determined the time intervals during which different classes of students were at the optimum amount of information, should accomplish a given task in the map. The fact indicates that the students performed the task correctly within a specified period of time, suggests that the appropriate map is correct.

In order not only to follow the investigator's opinion, the time intervals have been discussed with other teachers, some of whom were experts and methodologists. In the light of their comments and suggestions, it was finally formed the table with optimal time intervals.

Table 3. The time intervals during which the students belong to different levels of achievement have to carry out tasks on the map.

Levels / Classes	Upper level	Basic level	Satisfactory level
10	1 – 2 min.	2 – 4 min.	5 – 7 min.
9	2 – 3 min.	3 – 5 min.	6 – 9 min.
8	3 – 4 min.	4 – 7 min.	8 – 10 min.
7	5 – 7 min.	7 – 9 min.	9 – 12 min.
6	6 – 8 min.	8 – 10 min.	10 – 15 min.

Taking into account factors such as human factors, often occurring in students' distraction and similar factors, it was accepted, provided that in order to conclude that the graphic information load in the map fragment (according to the results of the task) is appropriate for a defined time frame to get at least 80% of each group of students, and of which no less than 60% of the tasks to be fulfilled properly.

Each student belonging to mentioned achievement level has received the map with different graphic and information load.

Students used the geographic computer program “Eye – M 2.0”. They analyzed thematic maps and adding or removing the information layers tried to understand the content of the maps. It was important to pay attention on students’ reaction and perception when changing the information layers they were reading content of maps with different graphic information load.

The new term was introduced:

General optimal map load - this is the optimum content of graphic information load in the map centered on the pupil of a certain age ability to understand the optimum amount of information.

The first part of the experimental research was done with the help of geographic computer program “Eye – M 2.0” which is made on the background of Geographic Information System (GIS). “Eye – M 2.0” is one of the models of GIS oriented to school geography (Krupickas, Olberkyte, 2004). Comparing with other geographic computer programs fitted for school geography this one includes many GIS functions that were necessary during the research. GIS in education could be used in different levels depending on pupils learning abilities and knowledge of GIS and teaching subject as well (Keiper, 1999, Kerski, 2001, West, 1999).

Using “Eye – M 2.0” students were working with different maps. They had to find rivers and lakes, mountains and lowlands, countries and towns and analyze the information in different aspects. The function to add the new layers to the map or to remove them provided the possibility to identify when the index of general optimal map load in the map is to low or already too high. This part of experiment was a visual analysis, which required mathematic calculations.

The aim of the second part of the research was to create the formula and using it to compute the general optimal map load in the training maps for different atlases. As the result calculations identified the indexes of general optimal map load and indicated which maps are fitted for the appropriate classes, which are not.

In the second part of the research using the formula the researcher identified the general optimal map load in the training maps. The measures such as length of linear object were made using ArcMap 9.3.1 version.

The last research was done on the purpose to understand how pupils of different levels can find the objects in the location using very simple map with the marked places. The most important aim was to identify the evaluation of spatial thinking of pupils from different classes. Also it was found that pupils form different classes' respected different thing when they are taking into account things as an important landmark.

3. RESEARCH RESULTS

Applying GIS into geography teaching in Japan

The study intends to find out the real ways how Japanese geography teachers integrating Geographical Information System, into geography lessons in junior high schools in Japan. The data collection was done through:

1. Actual observation of geography classes in junior high schools in Japan.
2. Interview with geography teachers about the usage of Geographical Information System in lower secondary schools in Japan.
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Class observation. During the research there were observed three geography classes in junior high schools and one in upper secondary school in Japan. The class observation in upper secondary school was done in Komaba school. Two observations were done in Keio Gijyuku Futsubu junior high school. One more geography class was in Tsukuba Daigaku Fusoku junior high school. These schools are advanced schools in using GIS and can not be considered as a representative of GIS using in geography lessons in junior high schools in Japan. These schools can be a very strong guide to become aim in order to develop GIS during geography lessons in lower secondary schools in Lithuania.

The main purpose of the observation was to observe and study the teaching methods and the ways of integration of GIS in geography teaching to promote pupils geographical skills.

During the geography class observation it was found that apart textbooks and paper maps, Japanese geography teachers are using many innovations in teaching, for instance, computers, internet, projectors, video, geographical computer programs ("Green Map"), GIS programs such as "Chizu Taro", computer application programs ("Power Point", etc.).

Noticeable points observed are as follows:

1. Innovations can motivate and encourage students to learn, because they are very interested in the lesson and want to try to use the computer or any geographic computer program provided for each activity of the class in order to improve geographical skills.
2. It is noticed that some students do not know how to use some software. If they do not know how to manage it well as the result it causes them to get bored with the whole class activities.

3. It is also important that some students do not want to work with GIS, because they afraid to make mistakes.

4. GIS in education could be used in different levels depending on pupils learning abilities and knowledge of GIS and teaching subject as well.

5. Moreover, Geographic Information System is not only a tool that supports the teaching – learning process. It is also a method which helps students and teachers engage in studies that promote critical thinking, integrated learning, and multiple intelligences, at any grade level.

6. The teachers must have enough competence to work with Geographic Information System.

Interview with geography teachers**.** There was an interview with 5 geography teachers. The time for interview was about 50 minutes in average. The information carried out during the interview shows the situation of geography teaching in junior high school in Japan in two parts. One part is about teachers' perception of using GIS in teaching. Another one is about the way of using the software and the results.

During the conversation, some teachers argued that GIS really increase students' geographical skills. However teachers should have clear aims for using technologies in class. For example: *"Teachers should integrate Geographic Information System when they are doing with students some projects where as a result pupils must to create their own maps or do the presentation"*.

The interview states that only few Japanese geography teachers are able to use GIS during their lessons in junior high schools. They argue that there are a lot of difficulties applying the GIS software into teaching. Teachers have not enough competence to work with software, lack of time because they are very busy working in other spheres. Some schools even can not buy GIS software, because the license is expensive. Moreover, some students in lower secondary schools do not have enough skills to use computer or manage software.

Rresults of questionnaire. The questionnaires were divided to 15 junior high schools geography teachers in Ibaraki Prefecture and Tokyo. It was decided to give these questionnaires only to teachers from special schools which are attached to universities, in case to avoid asking for the permissions from schools principles. The content of the questionnaires is concentrate on GIS integration into geography teaching in junior high schools.

The results of the questionnaires showed that 11 teachers are using information technologies during geography lessons, other 4 do not (table 4).

Table 4. Using Information Technologies in geography teaching

Do you integrate Information Technologies in geography lessons?	**Number of teachers**	**Respondents (%)**
Yes	11.0	73.3
No	4.0	26.7

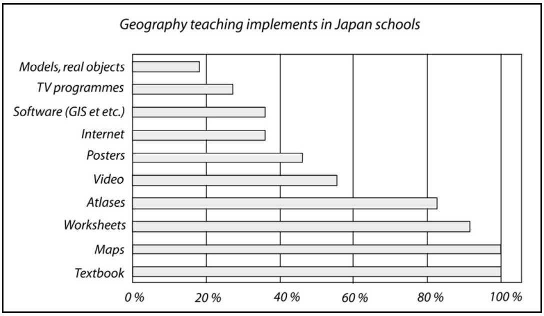


Fig.2. Materials which teachers use in geography lessons

The figure 2 presents what kind of materials geography teachers are using in junior high schools. According to the data, all teachers are using textbooks and maps. But they rarely use teaching materials such as TV programs, internet, GIS and video. It is really surprising that teachers do not use slides at all.

Table 5. How often you are using GIS in geography lessons?

How often you are using GIS in geography lessons?	**Number of teachers**
1 hour	5
2 hours	2
1 or 2 times into two weeks	3
1 time per month	1

Table 5 shows that some of teachers are using GIS in their lessons quit often. But they argue that it depends on the topic of the lesson or some project stages.

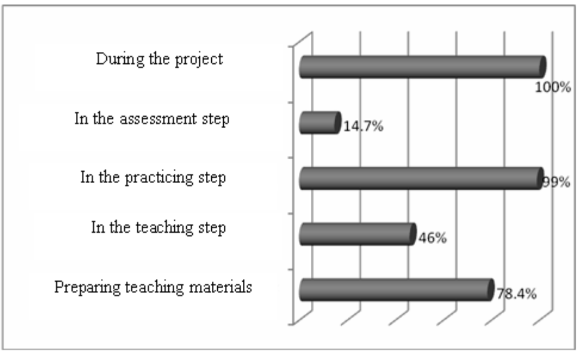


Fig. 3. In which teaching steps teachers use GIS in geography lessons?

According to the figure 3, teachers and students are using GIS mostly during different projects. It also clear that GIS is not very acceptable tool in the assessment step.

Table 6. Reasons to start integrate GIS into geography teaching

The main reason why you integrate GIS in geography teaching	Respondents (%)
GIS enables students to learn by doing	100%
GIS enables to develop students geographic skills,	80%
GIS enables to work using new technologies	60%
GIS enable students to have the positive attitude toward geography	100%

The table 6 shows that the main purposes of using GIS in the class are to encourage students to learn by doing that promote them to self direct learners and also to form their positive attitude toward geographic learning.

In general geography teachers are thinking that GIS helps students to improve geographical skills and they recommend use innovations together with traditional teaching methods.

Applying GIS into geography teaching in Lithuania

It was necessary to know the pupils ability to use the GIS on the purpose to use geographic computer programs (based on GIS functions) for the serious further researches in the junior high school level.

The goals of the experiment were:

4. To find out pupils position on computerize geographic learning;
5. To clear up pupils ability to use geographic computer programs (Eye - M 2.0);
6. To find out pupils priority to choose one of the methods to get information.

All figures demonstrate that pupils’ ability to use different methods to get and analyze geographic information depends on their age (Bevainis, 2005, 2006).

The best way to prepare pupil to use GIS, is let them work on a project using very common geographic computer programs like "Eye – M 2.0". This program gives possibility to measure area perimeters, azimuth, and distance between two points; also pupils can create new layers and objects in digital maps and so on. Working on a project pupils must have a possibility to make a choice which method to get information they want to use. It must be a choice because it depends on which classes are doing a project (Fig. 4 – 7). This way of working is more interesting for pupils then old methods.

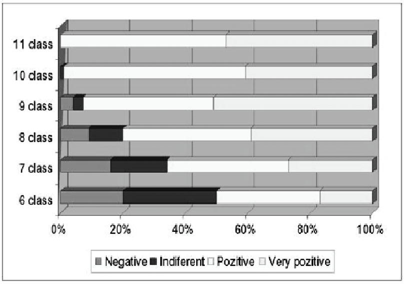


Fig. 4. Pupils pozition on computerize geographic learning

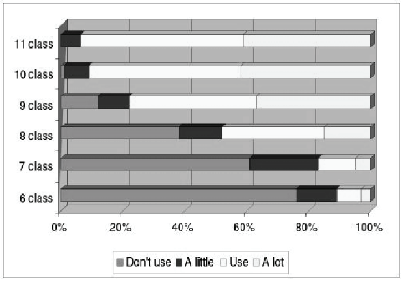


Fig. 5. How do pupuils use GIS in the project?

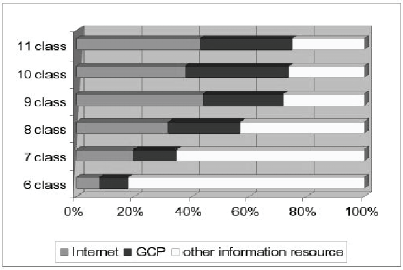


Fig. 6. Pupils priority to choose one of the methods to get information in the project

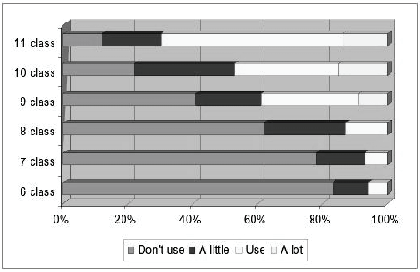


Fig. 7. Pupils ability to use GIS in the project

Identifying the general optimal map loads for all levels of the junior high school

During the first part of the experimental research there were participating pupils from 6 till 10 classes – totally 294 students. During the research there were analyzed administrative maps, physical maps and economic maps designed for different classes. Totally there were analyzed 157 maps (fig. 14, 15, 16, 17). Working with "Eye – M 2.0" it was set the reference maps. These maps were used to calculate and set general optimal map loads (Bevainis, 2009, 2011).

An example of the workflow of the first part of the research. Students selected maps with different graphic and information loads. Time recorded during the task was compared with the distinguished time intervals. Concerning that maps differentiated according to their graphic and information load:

1. Fragments of maps, with a highly graphic and information overload;
2. Fragments of maps, where graphic and information load is normal;
3. Fragments of maps, in which general optimal map load is low.

Students were receiving new maps with different graphic and information load as long as they identify that visually the amount of general optimal map load seems acceptable.

Using "Eye - M 2.0" program, VI a class students were received maps with different graphic and information load. Firstly, students received the map fragment 1

"Lithuanian minerals ". Following the task, the children was apparent that they are confused and do not know where to start. Students said that there is too much different information in the map that is distracting them (fig. 8). The results showed that 15% of upper level VI class students were not able to finish the task in time, unfortunately none of them carried out correctly. The remaining students did not fall into time interval and also did mistakes. It is proofed that this map fragment is too complicated for students, because of graphic information overload.

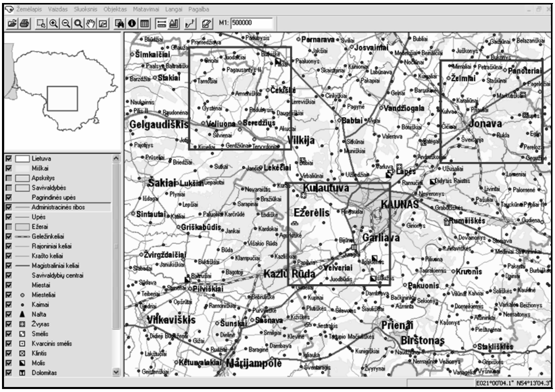


Fig. 8. "Lithuanian mineral" map fragment 1, where VI class students performed the task.

Students received “Lithuanian mineral" map fragment 2 for the assessment, some students using the rejection method indicated that an unnecessary part of linear, incremental signs, as well as notes on the map should be refused (table 7).

Table 7. Selection of elements of geographic basis for "Lithuanian minerals" map fragment 2.

The name of a layer	The number of objects	Filter criteria	Number of items left on the map	Number of items left on the map (percent)
Graphic layer “vilages”	3636	A random selection based on student feedback	664	18
Graphic layer “rivers”	301	A random selection based on student response (total river length> 50 km).	63	21
Graphic layer "	130	A random selection based on student response (total	20	15

national roads"		length> 30 km).		
Graphic layer "district roads"	1912	A random selection based on student response (total length> 19 km).	217	11

Using of "filter" on the map has been reduced by a dense network of rural-type settlements, and only 664 left of the village of 3,636, which represents about 15%. Similarly rejected a number of rivers where total length are less than 50 km., 301 rivers and therefore the remaining 63, which represents about 80% of all rivers. It also has reduced the road network density. Graphic layer of the national roads was filtered number of national roads where total length are less than 30 km., and thus remained on the map 15% of all national roads. Graphic layer of regional roads, remove road less than 19 km. This means that as the map has remained at about 11% of all regional roads.

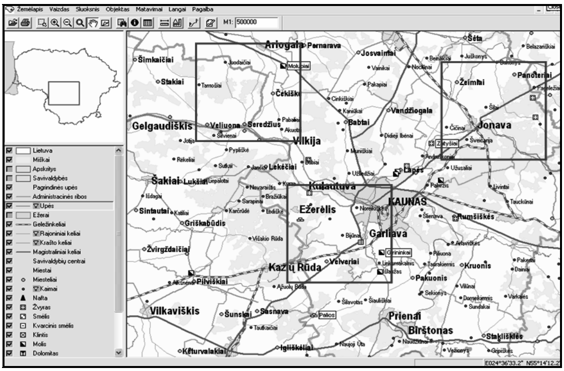


Fig. 9. Selected "Lithuanian minerals" map fragment 2, where VI class students performed the task.

Upon receipt of an acceptable visual version of the map (fig. 9), students began to work. The results showed that even 93% of upper achievements group of students, finished the task on time, only 8% of students made errors. 89% of the basic achievement group of students also entered into a time interval and they made a mistake by only 11%. Finally, the achievement of a satisfactory group of children performed the task on time 81% and 14% of them had occurred (Fig. 10).

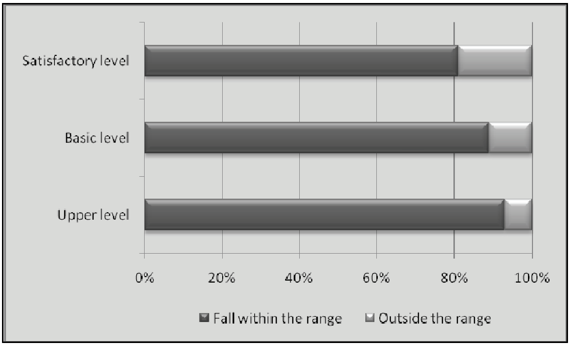


Fig. 10. Sixth class students task results using map fragment 2, during identified time interval.

Results represented in figure 8 show that the general optimal map load in map fragment 2 is correct for VI class pupils.

Atlas maps for VII, VIII, IX and X classes were assessed in the same way, as well as was presented an example with maps for VI class.

After the first part of the research it was created the formula according to four cartographic elements, which influence general optimal map loads: lines objects, areas, points and notes. For the calculation of four cartographic elements it was taken a conditional area in the map – 25 square centimeters. 25 squire centimeters was a conditional area and depending on situation calculations could be done of a whole map as well. The map scale in the calculations was not necessary because according to generalization the general optimal map loads must be the same using different scale (fig. 8, fig. 9).

$$\mathbf{L_m = L_l + L_a + L_p + L_n}$$

L_m – An index of general optimal map load in the map which shows the density of cartographic signs in the appropriate area.

L_l – The sum of linear signs in the conditional area in the map.

$$L_l = \frac{\sum l}{c}$$

l – The quantity of linear objects.

c – A conditional area in the map.

L_a = The sum of area signs in the conditional area in the map.

$$L_a = \frac{\sum a}{c}$$

a – The quantity of area objects.

c – A conditional area in the map.

L_p - The sum of point signs in the conditional area in the map.

$$L_p = \frac{\sum p}{c}$$

p – The quantity of point signs.

c – A conditional area in the map.

L_n – The sum of the letters of notes in the conditional area in the map.

$$L_n = \frac{\sum n}{c}$$

n – The quantity of letters of notes.

c – A conditional area in the map.

During the electronic maps analysis there were identified three categories of general optimal map load for each analyzed map:

1. Low graphic information load;
2. Optimal graphic information load;
3. Overload of graphic information.

Using the formula described before $\mathbf{L_m = L_l + L_a + L_p + L_n}$ there were made the calculations to express low, optimal and overload of graphic information in appropriate intervals.

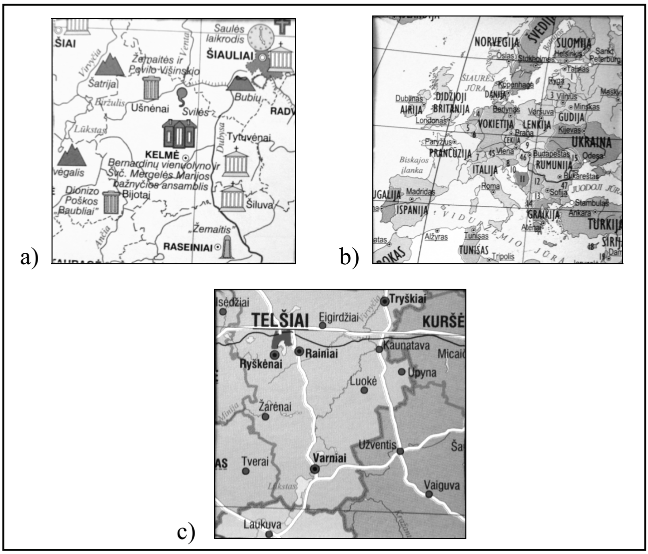


Fig. 11. Some examples of analysed maps: a) The places of interest of Lithuania. 9 - 10 classes. “Sviesa”; b) Political map of the World. 6 class. “Briedis”; c) Political map of Lithuania. 6 class. “Briedis”.

Essential influences for optimal index of general optimal map load have the spread of different maps elements groups (Fig. 11).

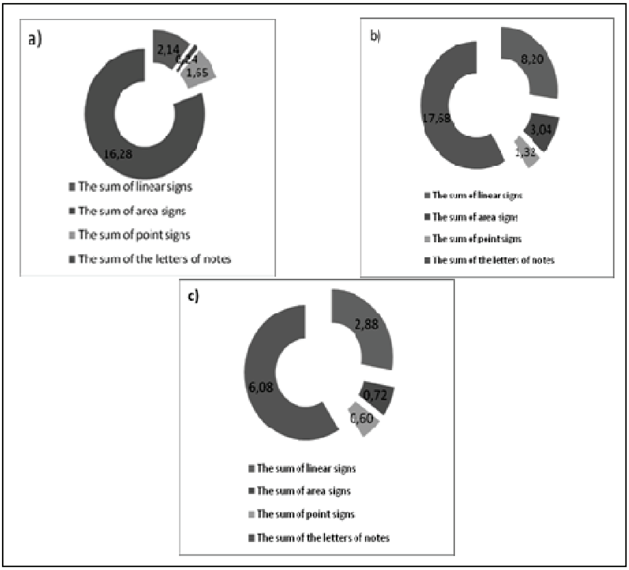


Fig. 12. Different graphical signs group structures of analyzed maps. a) The places of interest of Lithuania. 9-10 classes. “Sviesa); b) Political map of the World. 6 class. “Briedis”; c) Political map of Lithuania. 6 class. “Briedis”.

Experimental calculations showed that the optimal index of general optimal map load for 6^{th} classes is about 8. The optimal index of general optimal map load for 7^{th} – 8^{th} classes is about 12 and for 9^{th} – 10^{th} is about 22. As you can see in the figure 13 there are identified 3 intervals of general optimal map load for 6 – 10 classes. The interval of general optimal map load for the 6^{th} class is from 4 to 9, for the 7 – 8 classes is 6 to 13 and for the 9 – 10 classes is 11 to 18.

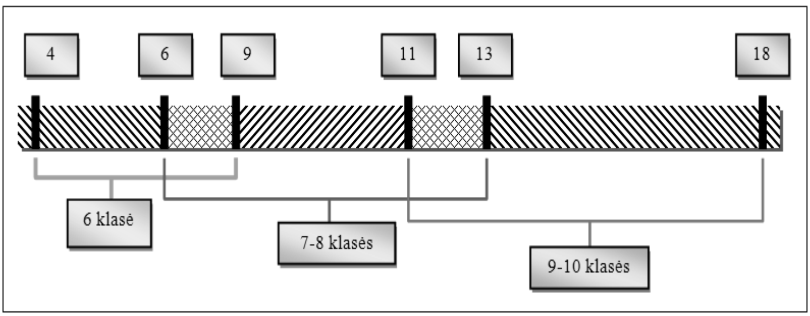


Fig. 13. Intervals of general optimal map loads for VI – X classes.

In the second part of the survey when the intervals of available general optimal map loads were clear there were taken the most usable atlases in Lithuania (publishers are "Sviesa" and "Briedis") and in Japan for the calculation of the general optimal map loads in the maps. The results of calculations of general optimal map loads of atlases maps showed that there are maps with incorrect values of general optimal map loads for different age pupils (Bevainis, 2009).

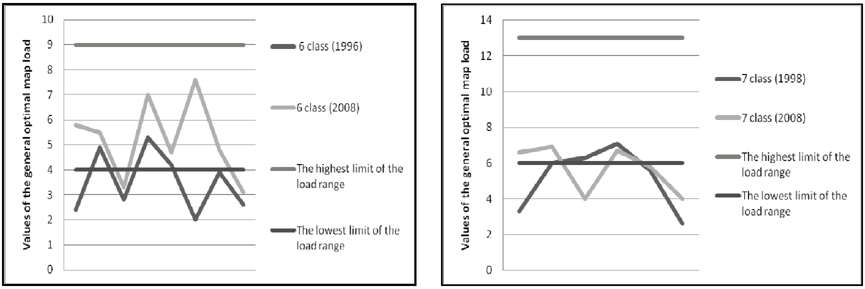


Fig. 14. A comparison of the values of general optimal map loads for the different years of educational geographic maps of the publisher "Briedis".

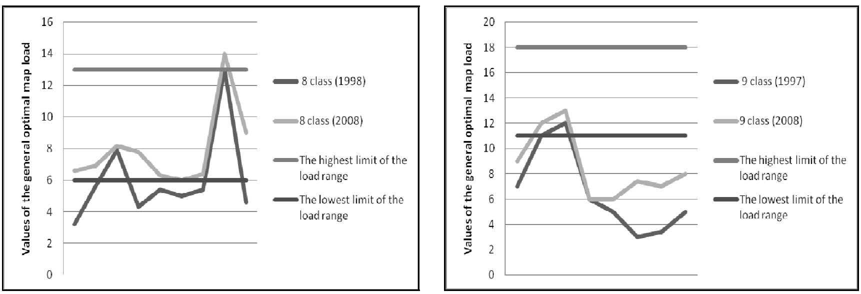


Fig. 15. A comparison of the values of general optimal map loads for the different years of educational geographic maps of the publisher "Briedis".

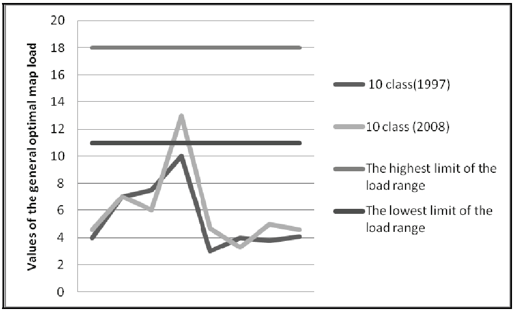
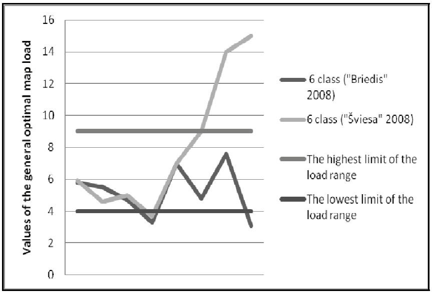


Fig. 16. A comparison of the values of general optimal map loads for the different years of educational geographic maps of the publisher "Briedis".



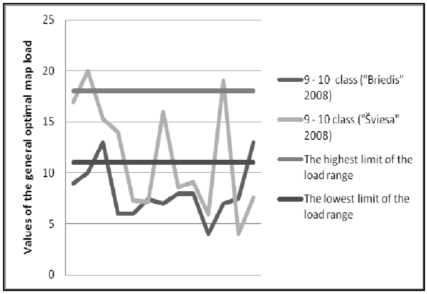


Fig. 17. A comparison of the values of general optimal map loads for the different years of educational geographic maps of the publisher "Briedis".

The results of calculations of general optimal map loads of atlases maps showed that there are maps with incorrect values of general optimal map loads for different age pupils (Fig. 14, Fig. 15, Fig. 16, Fig. 17).

CONCLUTIONS

1. Aplying GIS into geography lessons are not a mass phenomenon in Lithuania and abroad, but it is widely used in countries where information technologies are well-developed, teachers and pupils have very positive approach about integrating the technology in geography lessons.

2. Concerning the the complexities of differential school system in Japan does not apply GIS in all major schools. The main obstacle in Lithuania to apply GIS software is a weak computer base of schools and teachers' inability to work with information systems.

3. It was found that the usage of GIS in geography lessons promote students spatial thinking, promote self-employment, allow them to find analytical solutions, creating maps and performing their analysis.

4. Analyzing the information of the map students (11 to 13 years) are able to formalize cartographical signs of the map, embraces them with the actual objects of location. Using GIS functions older students are able to perform data sorting, comparison of objects and the distance measurement operations, etc.

5. The author proposes a new pragmatic criterion - a common optimal map load that shows the common optimum map load ratio, which is geared to a certain age of student's ability to percept the optimum amount of information. Studies have shown that the incorrect value of the general optimal map load can prolong the time of the task and affects the amount of errors.

6. The critical elements of cartographic information determine general optimal map load volume and speed of perception of school maps and verification of the content. The information value of these elements is much higher than other cartographic elements values. Studies have shown that the main and major critical element in educational maps is incorrect amount of text elements. Chaotic localization of notes, the lack of clear natural or anthropogenic guidance and density of cartographic linear elements are complicated by the legibility of the map and perception of information for VI - VIII class students.

7. Pupils of IX and X classes the attention focuses on the map legend. That leads better educated spatial thinking and environmental awareness. The maps prepared for these classes students should be more informative, with a more thematic signs maps for thematic maps.

8. Studies have shown that the newly awarded content of school maps is not renewed in respect of the map content information load. Maps with a low common optimal load were found in publishers 'Briedis' atlases and maps with general optimal overload determined in publishers "Šviesa" (2008) atlas. It is noted that the newer maps for the same class have higher general optimal load then old maps.

9. The calculations during the studies showed that only 10% of maps of the atlas "General Geography for schools" ("Šviesa") according to general optimal load are balanced for VI class. Optimal values of average general optimal load of the maps for elementary school classes are: class VI - 7, VII and VIII classes - 9, IX and X classes - 15.

10. Studies have shown that an imbalance of general optimal load of the maps was found during the analysis of atlases in other countries. It was noticed 88% of the maps in Japanese geographic atlas that are above the optimum load values which were identified during the experiment in Lithuania schools. Students of the VI class analyze the map and particular draw attention to elements of the text as the clearest map information element to understand. With increasing age, students gradually move away from the main analysis of the text to read symbols.

11. The publishers of school cartographic production should carefully review their maps and make a balance of the general optimal maps loads according to students' needs. Geography teachers and students should not be limited tofor only one cartographic publishing output. Using GIS in geography teaching can solve the problems related with information overload in training maps.

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Scientific interests	Pedagogical cartography, GIS in school education, general optimal map loads in training maps.

SANTRAUKA

ĮVADAS

Temos aktualumas

Iki šių dienų dauguma žmonių įpratę naudoti atspausdintus popieriuje žemėlapius. Spartus progresas kompiuterinių technologijų srityje paskatino virtualių žemėlapių gamybą, kurie egzistuoja skaitmeniniame formate ir yra matomi tik kompiuterių ekranuose, todėl juos galima vadinti nematomais ir nematerialiais, nes juose esanti grafinė informacija saugoma kietajame diske, o patį žemėlapį galima naudoti tik prisijungus prie duomenų bazės (Moellering, 1980).

Tradiciškai, tiek suaugę žmonės, tiek moksleiviai, buvo įpratę naudoti žemėlapį pasidėję priešais save. Vystantis technologijoms ir žemėlapiams tapus interaktyviais, vartotojai turi daugiau naudojimosi žemėlapių galimybių tokių kaip pasirinkti reikimą grafinį sluoksnį, prisijungti prie erdvinės duomenų bazės, kurioje gali ieškoti duomenų, keisti duomenų atvaizdavimo būdą žemėlapyje, naudoti įrankius atlikti analizei, galiausiai sukurti savo paties žemėlapį. Programinė įranga leidžianti atlikti minėtas ir dar daug kitų funkcijų vadinama geografinėmis informacinėmis sistemomis (toliau – GIS). Skirtingai negu tradiciniai žemėlapiai paprastai atvaizduojantys informaciją, interaktyvūs turi galimybę jungtis per nuorodas prie konkrečių vaizdų ar garsų. Tokie žemėlapiai yra dinamiški, todėl gali rodyti pokyčius per tam tikrą laiką.

GIS technologijos leidžia vartotojams kurti teminius žemėlapius, kurių duomenys yra saugomi duomenų bazėse. Duomenys gali būti susieti su žemėlapiais įvairiai – kaip plotai (valstybių teritorijos), kaip taškai (miestai) ar tiesiog išreikšti grafikais ir diagramomis. GIS yra dinamiškas – atnaujinus duomenis duomenų bazėje, automatiškai atsinaujina duomenys žemėlapyje. GIS leidžia vartotojui vizualizuoti ir analizuoti erdvinę informaciją naujais metodais, atskleidžiančiais anksčiau paslėptus erdvinius ryšius, struktūras ir tendencijas.

Visa tai įpareigoja mokytojus padėti mokiniams suvokti principus kaip interaktyvūs žemėlapiai yra sukurti ir kaip su jais dirbti, kad būtų išnaudotas visas jų potencialas. Be to dirbant GIS technologijomis keičiasi ryšys tarp mokytojo ir mokinio. Deja, GIS ir skaitmeninė kartografija yra revoliucija, kuri vis dar ne iki galo įvyko mokymo sferoje.

Nenaudojant GIS technologijų, prarandama galimybė dirbti su žemėlapiu interaktyvioje erdvėje, kur grafinių duomenų kiekį žemėlapyje galima pačiam nusistatyti pagal poreikį. Kitais žodžiais tariant, atsiranda galimybė pačiam vartotojui nusistatyti optimalų grafinės ir informacinės apkrovos kiekį žemėlapyje. Kalbant apie teminius įvairioms sritims pritaikytus žemėlapius, tokius kaip dirvožemių, geologinius ir pan., juose kartografinis vaizdas rengiamas remiantis nustatytais standartais tiek sutartiniams ženklams, tiek grafinei ir informacinei apkrovai (Dumbliauskienė, 2003).

Deja, mokyklinių atlasų skirtų konkrečioms klasėms žemėlapiai yra sudaryti be aiškių rekomendacijų jų turiniui. Problema ta, kad edukaciniuose žemėlapiuose pateikiamas grafinės ir informacinės apkrovos kiekis yra ne visada tinkamas skirtingo amžiaus mokiniams, atliekant užduotis bei ieškant informacijos, sunku orientuotis ir lengvai suvokti žemėlapio turinį. Kitaip tariant informacijos kiekis pateikiamas žemėlapiuose nekreipiant dėmesio į moksleivių amžių, jų suvokimo galimybes. Nėra atlikta pakankamai tyrimų nei Lietuvoje, nei užsienio valstybėse, kurie leistų kurti optimalų kartografinį vaizdą, pagal skirtingo amžiaus mokinių informacijos suvokimo galimybes.

Darbo mokslinė problema. Autoriaus tyrimų metu iškelta mokslinė problema grindžiama prielaida, jog mokytojai ir mokiniai naudojasi daugeliu žemėlapių, su įvairia grafine ir informacine apkrova, kuria remiantis mokiniai turi suprasti ir atskleisti įvairių objektų erdvinius sąryšius. Tačiau iki šiol nesubalansuota kiekybinė ir kokybinė naudojamų žemėlapių grafinė informacija (aspektai), ji nesiejama su atitinkamais mokinių gebėjimais ir jų ugdymu. Todėl iškeliama nauja žemėlapių turinio edukacinės kokybės tyrimo problema.

Tyrimų objektas – mokykliniuose atlasuose analoginių ir geografinėse kompiuterinėse programose naudojamų skaitmeninių edukacinių žemėlapių kartografinis vaizdas vertinant jų turinio grafinę ir informacinę apkrovą.

Darbo tikslas – nustatyti optimalias grafinės ir informacinės apkrovos reikšmes edukaciniuose analoginiuose žemėlapiuose ir geografinių kompiuterinių duomenų bazėse, skirtose pagrindinės mokyklos moksleiviams.

Darbo uždaviniai:

1. Išnagrinėti Lietuvos ir užsienio valstybių patirtį, atliekant tyrimus susijusius su geografinių informacinių sistemų naudojimu geografijos pamokų metu;
2. Įvertinti edukacines geografines kompiuterines programas ir išnagrinėti jų taikymo galimybes Lietuvos mokyklose;
3. Parengti metodiką edukacinių žemėlapių kartografinio turinio grafinės informacinės apkrovos skaičiavimui;
4. Įvertinti edukacinių žemėlapių skirtų pagrindinės mokyklos moksleiviams optimalias grafinės ir informacinės apkrovos reikšmes.
5. Vadovaujantis sukurta metodika, įvertinti ir palyginti Lietuvos ir Japonijos leidėjų mokyklinių atlasų edukacinių žemėlapių grafinę informacinę apkrovą.

Mokslinis darbo naujumas.

Edukacijoje, kaip ir kitose srityse, plačiai plinta vizualizacija. Naujai žiūrima į tradicinius ugdymo proceso dalyvius ir priemones. Žemėlapis yra vienas seniausių mokyklos atributų ir, kaip mokymo priemonė, naudojama daugelyje dalykų bei įvairiose ugdymo srityse. Tačiau naujų – juo labiau originalesnių – žemėlapio turinio edukacinių tyrimų nėra. Šiame darbe autorius apibendrina GIS taikymo mokant geografijos Lietuvos bei Japonijos mokyklose patirtį, išsamius, pirmą kartą Lietuvoje atliktus mokinių kartografinių kūrinių suvokimo tyrimus, taip pat pateikia naują žemėlapio bendrosios optimalios (grafinės ir informacinės) žemėlapio apkrovos individualaus suvokimo analizės metodiką bei pateikia konkrečias bendrosios optimalios žemėlapio apkrovos rekomendacijas edukacinių žemėlapių sudarymui.

Praktinė darbo reikšmė.

Atlikti tyrimai leido visapusiškai įvertinti Lietuvos pagrindinėse mokyklose naudojamų atlasų žemėlapius. Jie parodė, kad dalies Lietuvos pagrindinėse mokyklose naudojamų atlasų žemėlapiai turi netinkamą bendrąją (grafinę ir informacinę) apkrovą.

Remiantis šia analize, pirmą kartą suformuluotos edukacinių bendrageografinių ir teminių žemėlapių bendrosios optimalios žemėlapio apkrovos skaičiavimo metodika, bei optimalaus taikymo rekomendacijos konkrečioms klasėms.

Ginami teiginiai:

1. Šiuolaikinėje edukologijoje informacijos valdymo sistemų taikymas per informacinių technologijų diegimą tapo sudėtine metodologine geografijos mokymo dalimi, leidžiančia visapusiškiau ugdyti mokinių kompetencijas geografijoje.
2. Lietuvoje mokant geografijos taikomos informacinės technologijos yra integrali geografijos mokymo programų dalis, atitinkanti esamus pasaulinius informacinių technologijų taikymo standartus edukacijoje, tačiau šių priemonių naudojimas nėra iki galo reglamentuotas.
3. Mokant geografijos turi būti įgyvendinamas kartografinių kūrinių suvokimo ugdymas, paremtas progresyviu intelekto formavimu, realizuojamu koncentrinėje Lietuvos mokymo sistemoje.
4. Lietuvos mokyklose dalyje naudojamų edukacinių žemėlapių bendroji optimali žemėlapio apkrova nėra korektiška ir neatitinka moksleivių geografinio suvokimo gebėjimų skirtinguose pagrindinės mokyklos mokymo lygmenyse.

Rezultatų aprobacija

7 moksliniai straipsniai ir vienas diplominis darbas yra publikuoti disertacijos tema. Detalus publikacijų sąrašas yra pateiktas po išvadų (anglų kalba) skyriumi.

Darbo apimtis ir struktūra

Darbas yra parašytas vadovaujantis Lietuvos Mokslo Tarybos rezoliucija Nr. VI – 4, 2003, kur pagrindinės dalys išdėstomos tokia tvarka: įvadas, tyrimų apžvalga, metodologija, tyrimų rezultatai, išvados ir literatūra. Darbe pateikiama 91 paveikslas, 23 lentelės ir 112 literatūros šaltiniai. Bendrai darbą sudaro 213 puslapių.

Moksliniam darbui vadovavo prof. dr. Algimantas Česnulevičius. Darbo vadovui noriu pareikšti ypatingą padėką už metodinį vadovavimą ir suteiktą pagalbą rašant disertaciją. Taip pat esu dėkingas konsultantei prof. dr. Marijonai Barkauskaitei už esmines edukologines pastabas bei patarimus.

IŠVADOS

1. Lietuvoje ir užsienyje GIS naudojimas mokant geografijos nėra masinis reiškinys, tačiau jis plačiai taikomas gerai išvystytas informacines technologijas turinčiose šalyse, kur mokytojai ir mokiniai teigiamai vertina šios technologijos panaudojimą geografijos mokyme.
2. Nustatyta, kad GIS naudojimas mokant geografijos formuoja mokinių erdvinį mąstymą, skatina dirbti savarankiškai, suteikia galimybę pačiam moksleiviui savarankiškai priimti sprendimus, kuriant žemėlapius bei atliekant erdvinių ryšių analizę jau esamuose kartografiniuose kūriniuose.
3. Vienas iš būdų sėkmingai panaudoti GIS pamokose – sudaryti auditorijai galimybę savarankiškai spręsti problemas. Tuo tikslu turi būti sudaromos grupės, kurios

sprendžia skirtingus pamokos metu iškeltus klausimus, reikalaujančius atsakymų naudojant GIS. Vėliau būtina gautus rezultatus pristatyti auditorijai.

4. Japonijoje GIS taikomas ne visose pagrindinėse mokyklose dėl sudėtingos mokyklų diferencijavimo sistemos. Lietuvoje ir kitose nagrinėtose valstybėse svarbiausias GIS taikymo trukdis yra silpna kompiuterinė mokyklų bazė bei mokytojų kompetencijos stoka dirbti informacinėmis sistemomis. JAV ir Vokietija labiau pažengusi GIS taikyme mokant geografijos. Tai lėmė modernesnis požiūris į mokymą, bei susiklosčiusi palankesnė politika GIS adaptuotų mokykloms kūrimui, bei mokytojų tinkamam parengimui.

5. Tyrimai parodė, jog visose nagrinėtose šalyse vyrauja vieninga nuomonė, kad GIS galima taikyti bet kuriame pagrindinės mokyklos lygmenyje, tačiau negalima visiškai atriboti naujų technologijų nuo tradicinių mokymo metodų, priešingai, rekomenduojama juos apjungti.

6. Moksleivių erdvinis mąstymas vystosi palaipsniui, priklausomai nuo jų amžiaus. Būtent todėl skirtingų klasių mokiniai suvokia skirtingus informacijos kiekius, bei skaitydami (analizuodami) žemėlapį pagrindinį dėmesį sutelkia į skirtingus žemėlapio kartografinius lementus.

7. Sudarant žemėlapius to paties hierarchinio lygmens kartografinių elementų užrašai turi užimti vienodą poziciją objekto atžvilgiu visame žemėlapyje. Tokiu būdu moksleiviai (ypač VI - VII) lengviau susieja kartografinį elementą, su jį apibūdinančiu ar įvardijančiu užrašu. IX ir X klasių mokiniai naudodami žemėlapį dėmesį koncentruoja į sutartinius ženklus. Tą lemia geriau išlavintas erdvinis mąstymas ir aplinkos suvokimas. Šių klasių mokiniams rengiami žemėlapiai turėtų būti labiau informatyvūs, turintys daugiau teminiams žemėlapiams skirtų ženklų.

8. Žemėlapyje pateiktos informacijos kiekį bei mokyklinių žemėlapių suvokimo greitį, taip pat turinio verifikaciją lemia kritiniai kartografiniai informaciniai elementai. Tai elementai, kurių informacinė reikšmė yra žymiai didesnė už kitų žemėlapio kartografinių elementų reikšmes.

9. Atlikti tyrimai parodė, kad pagrindiniu ir dažniausiai pasitaikančiu kritiniu kartografiniu elementu edukaciniuose žemėlapiuose yra nekorektiškai pateiktas didelis užrašų kiekis. Chaotiškas užrašų lokalizavimas, aiškių gamtinių ar antropogeninių orientyrų stoka bei tankus linijinių kartografinių elementų pateikimas žemėlapyje labai apsunkina žemėlapio skaitomumą bei informacijos suvokimą VI – VIII klasių mokiniams.

10. Žemėlapių su maža bendrąja optimalia apkrova daugiausia rasta leidyklos „Briedis“ atlasuose, o žemėlapių su informacine perkrova daugiausiai nustatyta leidyklos „Šviesa“ atlasų žemėlapiuose. Įvertinus leidyklos „Pradai“ pasaulio atlaso žemėlapių bendrąją apkrovą, nustatyta, jog apkrova labiausiai atitinka VII ir VIII klasės moksleivių poreikius. Taip pat nustatyta, kad žemėlapių bendrosios apkrovos disbalansas būdingas ir kitų šalių mokykliniams atlasams. Japonijos geografiniame mokykliniame atlase net 88 % žemėlapių viršija optimalias bendrosios apkrovos reikšmes nustatytas tyrime dalyvavusiems Lietuvos pagrindinės mokyklos moksleiviams.

11. Tyrimo rezultatai parodė, kad GIS naudojimas pamokų metu geriausiai išsprendžia nekorektiškų bendrosios optimalios žemėlapio apkrovos reikšmių problemą žemėlapiuose.

CURRICULUM VITAE

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2001	Geografijos studijų programos bakalauras, kartografijos kryptis, Vilniaus Universitetas
2003	Geografijos studijų programos magistras, kartografijos kryptis, Vilniaus Universitetas
2004	Geografijos mokytojo profesinės kvalifikacijos diplomas, Vilniaus Universitetas
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2004-2011	Geografijos krypties kartografijos studijos, Vilniaus Universitetas
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