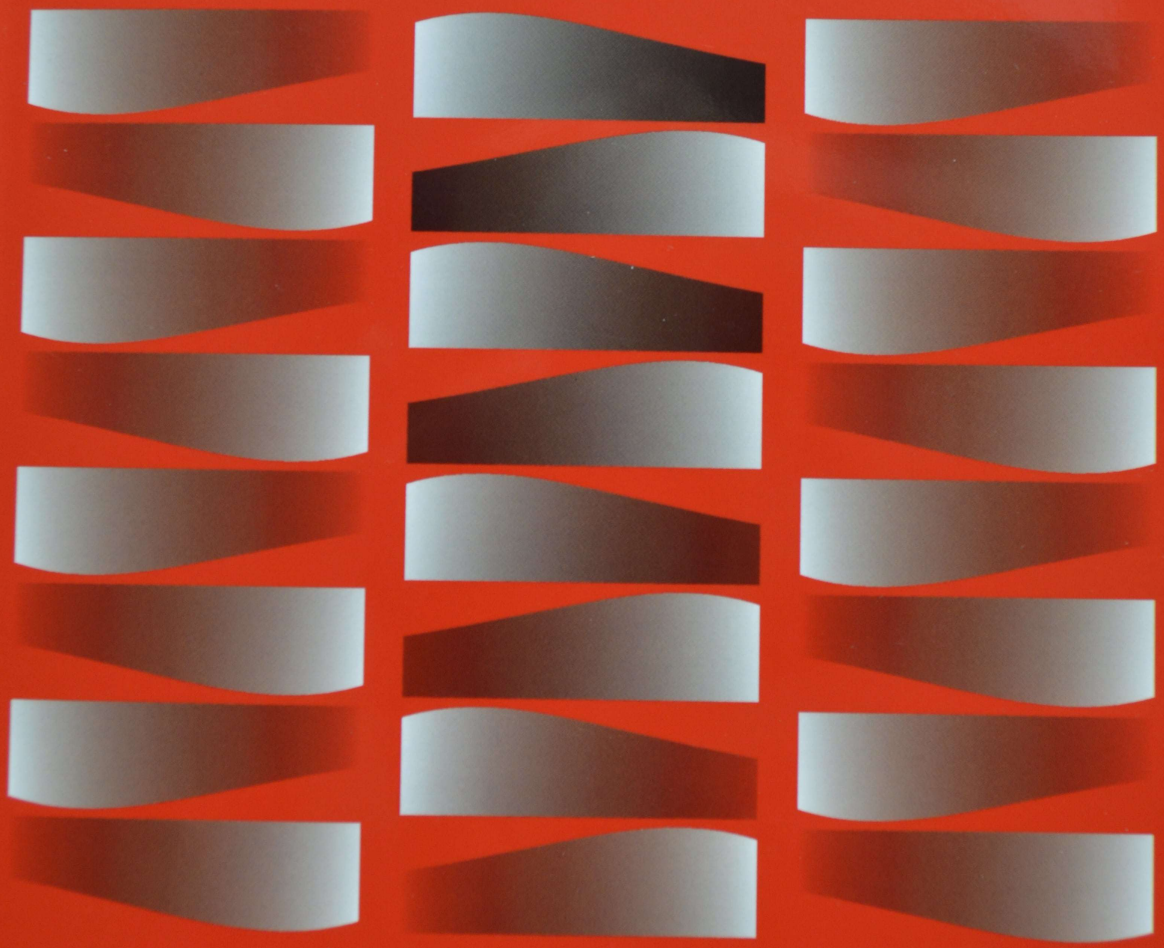
STUDIA SCIENTIFICA FACULTATIS PAEDAGOGICAE

UNIVERSITAS CATHOLICA RUŽOMBEROK



/4/ 2016

ročník XV.

KATOLÍCKA UNIVERZITA V RUŽOMBERKU

STUDIA SCIENTIFICA FACULTATIS PAEDAGOGICAE

UNIVERSITAS CATHOLICA RUŽOMBEROK

VERBUM

Ružomberok 2016

STUDIA SCIENTIFICA FACULTATIS PAEDAGOGICAE
UNIVERSITAS CATHOLICA RUŽOMBEROK
Rok 2016, ročník 11, číslo 4

Šéfredaktor: doc. PaedDr. Tomáš Jablonský, PhD.

Zostavovateľ: doc. PaedDr. Katarína Žilková, PhD.

Všetky publikované práce prešli recenzným konaním.

Publikácia je súčasťou riešenia projektu VEGA 1/0440/15 s názvom
Geometrické koncepcie a miskoncepcie detí predškolského a školského veku.

Za jazykovú úpravu zodpovedajú autori príspevkov.

Sadzba: Mgr. Anna Baroková

Obálka: doc. akad. mal. Pavol Rusko, ArtD.

EV 4416/11

Katolícka univerzita v Ružomberku

Hrabovská cesta 5512/1A, 034 01 Ružomberok
http://uv.ku.sk, verbum@ku.sk

IČO: 37-801-279

ISSN 1336-2232

Contents

GeoGebra a teória grafov v prostredí LMS Moodle

GeoGebra and Graph Theory in LMS MOODLE

Pavol Hanzel, Patrik Voštinár

Abstract

In this article we are focusing on creating electronic course for preparing future mathematics teachers. The course is created in system LMS Moodle. We will deal with creating eLearning lesson from Graph theory. We will show some possible ways of working with software GeoGebra in Graph theory. In GeoGebra we created new applets for the work with graphs.

Keywords: Moodle course, Graph theory.

MESC: U70

1. Introduction

Mathematicians since immemorial used different aids for simplifying calculations. In the second part of the 20th century appeared the first computers, which brought important technical element to education. Many international researchers e.g. PISA[1], TIMSS[2], SITES[3] investigated embedding computers directly into education processes. As a result of these researches it is possible to use computers in the education of natural sciences. This is one of the reason we decided to create eLearning course for discrete mathematics, especially for Graph theory.

2. eLearning course

In the Faculty of Natural Science at UMB we prepared eLearning course from Graph theory. The course is focused on teaching future teachers of mathematics. Our course is called "Vybrané kapitoly z diskrétnej matematiky". This course is available also for guests and it is located in the system LMS Moodle in the webpage:

https://lms2.umb.sk/course/view.php?id=1389

This course respects didactic functions of information and communication technology (ICT). The main functions of ICT are:

- **Motivation** - using ICT may help to improve approach of students to the topic and may increase their self-realization. This part includes two

[1] PISA (Programme for International Student Assessment) – http://www.pisa.oecd.org
[2] TIMSS (Trends in International Mathematics and Science Study) – http://www.uiv.cz
[3] SITES (Second Information Technology in Education Study)

areas. Strategic area means, that student have one strategic motivation aim. In our case it is electronic support in education. Tactic area is specific for concrete teaching aim, e.g. in part of "Connectivity of graph" it is "Shortest Path Algorithm".

- **Information** – means transfer of basic information. Important is the transfer of information and categorization into groups.
- **Management** – interactive teaching programs may manage systematic exchange between students and program. Our eLearning course is created in LMS Moodle.
- **Rationalization** – teachers are focused on important parts, big part of teaching is for self-study. Teachers can work differently (individually) with each student.

Our e-learning course is divided into four parts. The first part is focused on basic information about the course (learning materials, modified software GeoGebra, etc.). The second part contains eight e-learning lessons /lectures. The other two parts are focused on practicing on seminars and homework. In Fig. 1 the first two parts are shown.

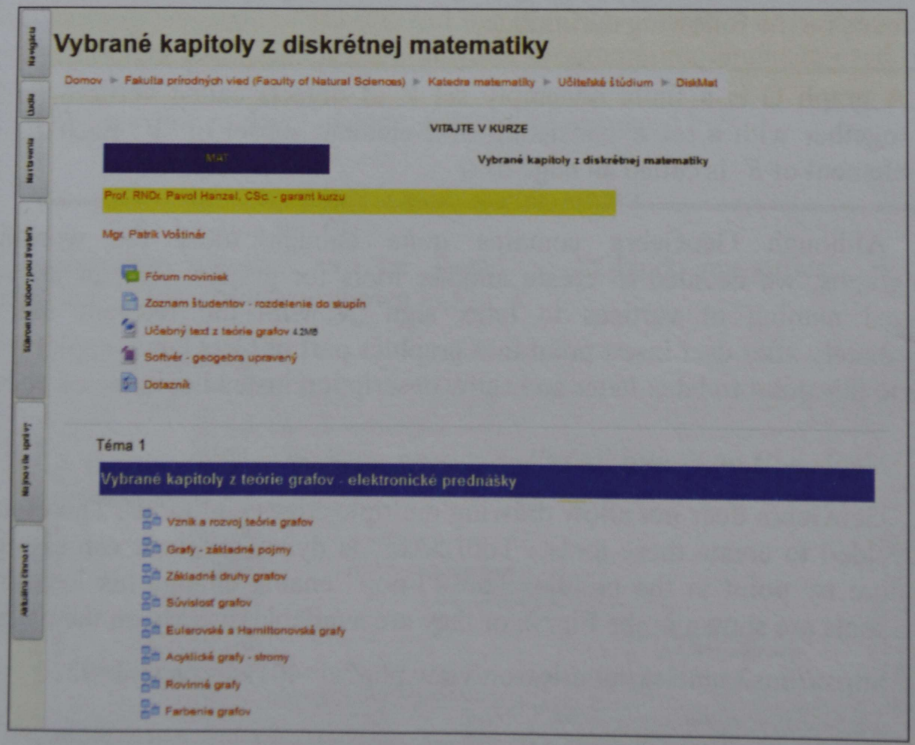


Fig. 1. eLearning course "Vybrané kapitoly z diskrétnej matematiky".

3. Dynamic software GeoGebra

Presently there exists many different geometric software for computers and tablets. These programs allow users to draw geometric shapes and also allows the users dynamically change their shapes, while retaining the existing links between geometric objects. With these dynamic geometric systems (DGS) students may explore and define hypotheses about properties and relations between geometric shapes. The most used DGS in our schools are Cabri II Plus, C.a.R and GeoGebra.

In our eLearning course we decided to use dynamic geometry software GeoGebra. The reason was, that GeoGebra is a free and multi-platform software for all levels of education, which allows embedding GeoGebra applets in Moodle course. This means, that GeoGeobra applets are directly in the webpage of some eLearning lesson in Moodle. The process of embedding applets into webpage of eLearning lesson is quite easy – so everyone should be able to do it.

4. Graph theory and GeoGebra

The basic term in graph theory is the term of graph. In this article we will focus on the following definitions.

> A graph G is a finite nonempty set V of objects called vertices together with a set E consisting of 2-element subset of V. Each element of E is called an edge of G

Although GeoGebra contains quite enough tools for working with graphs, we decided to create another tools for graphs. First of all we changed naming of vertices to latex sign „v“ with the relevant index. Immediately after user insert point into graphics part of GeoGebra, applet will rename this point to latex letter and show description instead of name of point.

Tools – “Loop” and “Arc”.

GeoGebra does not allow drawing multiple edges and loops. Therefore, we decided to create these tools. Tool “Arc” is dynamic - user can change curvature by point in the middle. Tool “Loop” enable change his location. These tools are shown in the Fig. 2, or they are available directly on the page:

https://lms2.umb.sk/mod/lesson/view.php?id=40195&pageid=9224

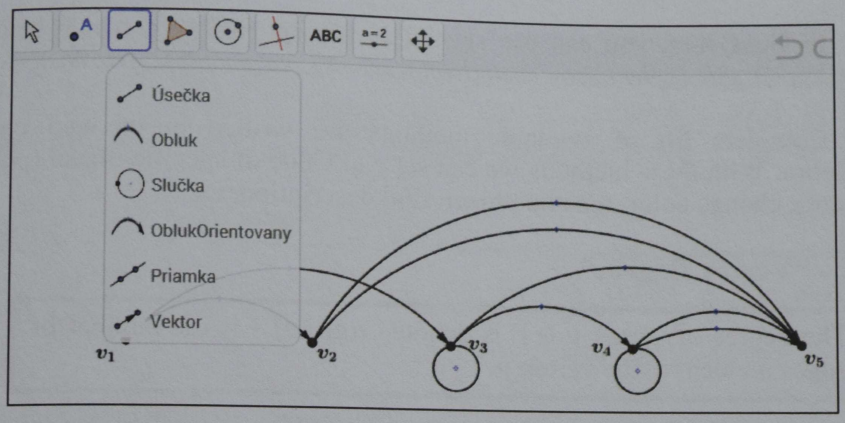


Fig. 2. GeoGebra tools.

Programming in GeoGebra

GeoGebra supports two programming languages:

- GGBScript[4]
- JavaScript[5]

We decided to use programming language JavaScript. JavaScript is the programming language of HTML and the Web. JavaScript is easy to learn. It is more famous than GGBScript – specific programming language used only for GeoGebra.

We are able to develop code, that can be triggered by:

- clicking an object
- updating object (e.g. changing value)
- loading the file

Scripting window can be found in "Object properties" → tab "Scripting". This window is shown in Fig. 3.

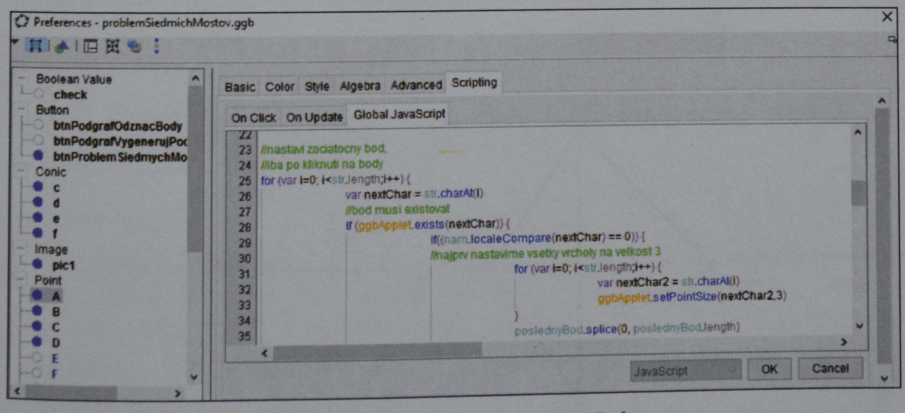


Fig. 3. Scripting window GeoGebra.

[4] https://www.geogebra.org/wiki/en/Scripting_Commands
[5] http://www.w3schools.com/js/default.asp

In GeoGebra, you can use special JavaScript methods, which belong to ggbApplet: *ggbApplet.nazov_metody(parameter1,parameter2,...parameterN);*

Complete list of available methods are written in the wiki page[6] GeoGebra. With these methods we can set e.g. value of specific object (point, segment), change color, rename object, find description, etc.

Tool – "Vertex Degree"

> The degree of vertex $v \in V$ is denoted $deg(v)$ - is the number of edges incident to the vertex v.

In Fig. 4 is shown tool „*Vertex Degree*", which is available on the web page https://lms2.umb.sk/mod/lesson/view.php?id=51739&pageid=11298

Applet contains graph, which is possible to edit by adding new vertices, removing one or more vertices. This applet also contains button „**Stupeň vrcholu**" and text $deg(v_1) = 3$. When the user presses the button, the color of the text in the button will be changed.

- If the text color is black, then the graph could still be modified (we are in common mode of GeoGebra). This is the default state of button.
- If the button was pressed, then the text color is red. Immediately as the user selects (click to) some vertex, applet will find how many edges are incident with this vertex. Edges incident with this vertex are highlighted and the number of these edges are written into text $deg(v) = ...$

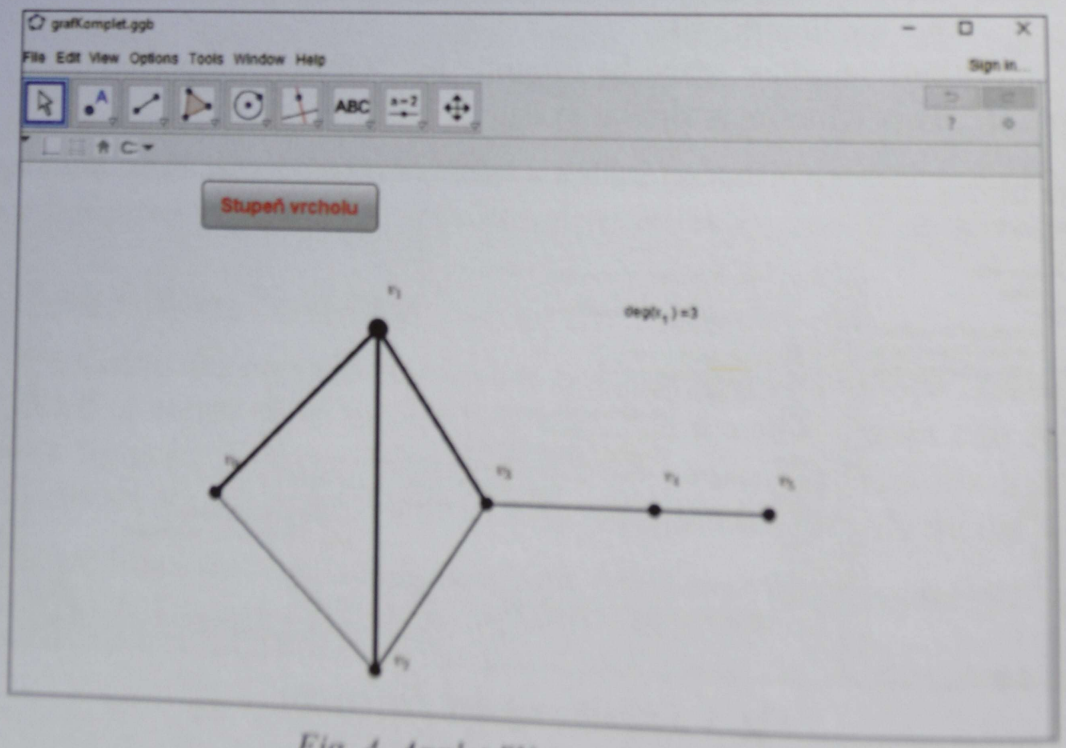


Fig. 4. Applet "Vertex Degree".

[6] http://www.geogebra.org/wiki/en/Reference:JavaScript

Tool – "Subgraph"

Let $G\,(V,H)$ be a graph and let $G_1 = (V(G_1), H(G_1))$ by a graph for that: $V(G_1) \subset V(G)$ and $H(G_1) \subset H(G)$.

Then graph G_1 is called subgraph.

Tool „Subgraph" is shown in Fig. 5. This applet is also available on webpage:
https://lms2.umb.sk/mod/lesson/view.php?id=51739&pageid=11302

This applet has similar functionality as the previous applet "Vertex Degrees". After the user presses the button "Vygeneruj podgraf", applet will highlight edges of selected vertices. Before pressing this button, user has to select vertices (using tool "Point"), which have to be used for subgraph. As you can see in the Fig. 5, selected vertices have bigger sizes as unselected vertices. In case that we want to cancel selection of some vertex, we have to click again at this vertex. The second way is to cancel all selected vertices by clicking on the button "Vygeneruj podgraf".

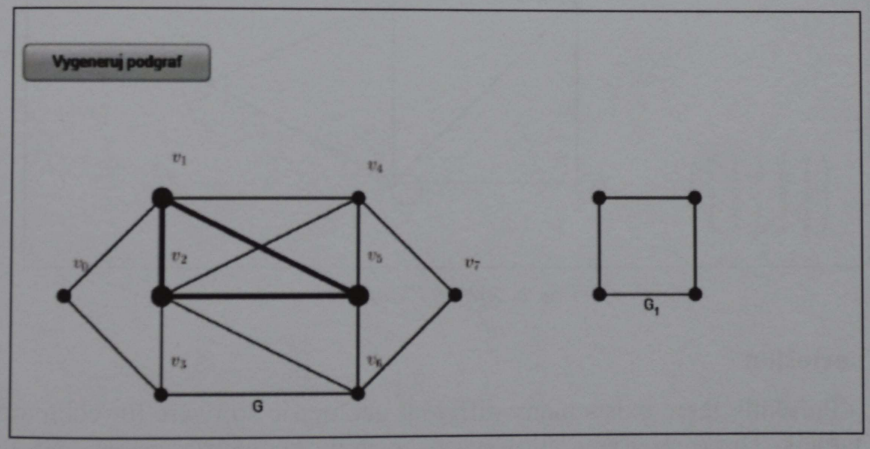


Fig. 5. Applet "Subgraph".

Tool –"Matrix"

Let $G = (V,H)$ be a graph with finite vertices set $V = \{v_1, v_2 \ldots, v_n\}$. The adjacency matrix $A(G)$ of G is the $n\,x\,n$ matrix in which the entry in row i and column j is the number of edges joining the vertices i and j:

$a_{ii} = k$, if $(v_i v_j)$ is $k - multiple\ edge$
$a_{ii} = 1$, if $(v_i v_i)$ is loop
$a_{ij} = 0$, if $(v_i v_j)$ is neither edge nor loop

Contribution been processed as part of the grant project electronic courses for the teaching of mathematics in primary schools and in the first 4 years of grammar schools. Project no. 003TTU-4 / 2015th

References

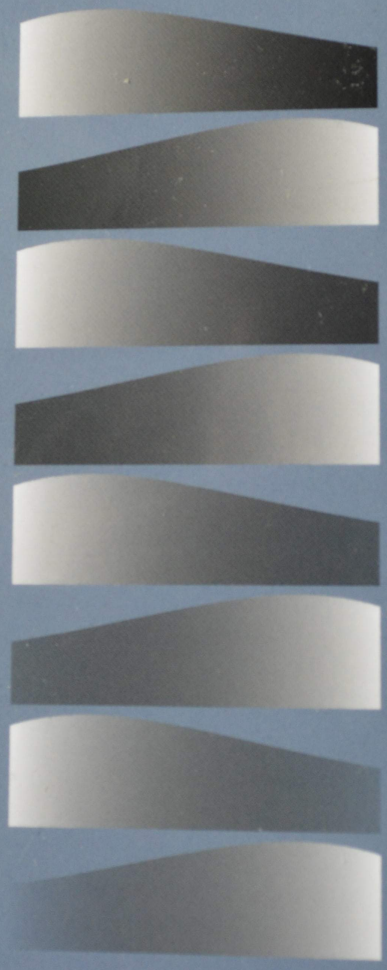
HANZEL, P. *Grafy a ich elevácie.* Pedagogická fakulta UMB, Bratia Sabovci Zvolen, 2005, ISBN 80-8083-120-3. Tiež dostupné na World Wide Web: https://lms2.umb.sk/mod/resource/view.php?id=52390

POKORNÝ, M. *Blended Learning as an Efficient Method for Discrete Mathematics Teaching*. Advances in Education Sciences, Vol. 1 (2013), s. 249-252. ISBN 978-981-07-5946-9, ISSN 2339-5141

SCHOLTZOVÁ. I. *Cesty diskrétnej matematiky (kombinatoriky) na základnú školu* [elektronický zdroj] 1. vyd. Prešov: Prešovská univerzita v Prešove, 2007. 139 s. ISBN 978-80-8068-579-9. Online: World Wide Web: http://www.pulib.sk/web/kniznica/elpub/dokument/Scholtzova1

ŽILKOVÁ, K. Dilemy v tvorbe e-kurzu Manipulačná geometria. In: *Matematika v primárnej škole - rôzne cesty, rovnaké ciele.* Prešov: Prešovská univerzita v Prešove, 2013. ISBN 978-80-555-0765-1, s. 276-280.

/4/ 2016
ročník XV.



ISSN 1336-2232