TEACHING AND LEARNING USING MULTIMEDIA

Eva Milková

ABSTRACT
In the contribution different approaches to using of multimedia presentations and programs will be discussed. First we will describe how and why we use the presentation Algorithms and their visualisation in the lectures prepared for the subject Algorithms and Data Structures. Then we will mention possibilities of using other presentations from the area of combinatorics in self-preparation of our students for the subject Discrete Mathematics. At the end we will mention the multimedia program called Graphs created in Delphi and used not only as an important support of the lectures but also within the WebCT virtual environment for the part-time students. The multimedia presentations will be briefly described in the paper and shown at the conference.

KEYWORDS
Multimedia programmes, algorithms, visualization of algorithms, combinatorics and their visualization

INTRODUCTION

Implementing modern information and communication technology into lessons enables an entirely new approach to education. There are several suitable virtual study environments available and a lot of possibilities of gaining suitable teaching packages and multimedia presentations. Also the rich intellectual potential of some of our students allows creating many useful programs.

In the article we would like to mention our teaching approach and effort to provide the students with teaching materials corresponding to the third millennium. We will show how we are trying to prepare interesting and object lessons by these means. We will concentrate on two areas: creation of algorithms and discrete mathematics. Both mentioned subjects are very important for increasing logical thinking of students. Nevertheless both areas are for some of them quite difficult.

ALGORITHMS AND DATA STRUCTURES (ALGDS)

At our faculty, Faculty of Informatics and Management of University Hradec Králové (FIM UHK) the creation of algorithms forms an inseparable part of the basic skills of the students whose specialisation is informatics. They must be able to think algorithmically, to create various algorithms solving given problems.

Several years ago secondary-school-students were taught how to create basic algorithms and write them into a program language as e.g. Basic or Pascal. But recently the situation rapidly changed in our country. User's approach has been increasing by students, but algorithmic approach is almost unknown for them. This was the reason why our faculty decided to change the curricula with regard to accepted students who have been coming to the faculty without any previous knowledge how to create algorithms.

Recently we started with teaching the program language Pascal immediately in the first term. But three years ago we included the new subject called Algorithms and Data Structure in the first term of study

before the subjects that deal with program languages. Students have the textbook [1] available and the program Algorithms and their visualisation serves as a very good instrument in the lectures.

Now we will briefly describe *our main idea of teaching basic algorithms*.

Imagine a brick-box, which is a nice and useful game for children. There are only several base elements available from children are able to create incredible buildings. So we use this idea also when creating algorithms.

After explaining all needed terminology (this means the term algorithm, variable, command, etc.) students start be familiar with following *basic algorithmic constructions* using the below-mentioned description only.

The postulate on description in bellow-mentioned form only is important for better intelligibility not only by the explanations of algorithms but also by checking them.

Sequence:

```
begin
  command1;
  command2;
  …
  commandn;
end
```

Selection:

part selection

```
if condition then
  command1;
```

full selection

```
if condition then
  command1
else
  command2;
```

Iteration:

```
while condition do
  command;
```

We add one form more for the special case of iteration. The case when we know the number of iteration and the step equals one and so we can use shorter description of the iteration.

With help of these mentioned descriptions we continue building *typical constructions* for solving various tasks dealing with one-dimension fields first, as for example [1]:

Finding out the number of elements with the given property V
(our task is to determine the number of elements in the sequence a_1, a_2, …, a_n having the given property)

```
begin
  number := 0;
  i := 1;
  while i ≤ n do
    begin
      if a[i] has the property V then
```

```
        number := number + 1;
      i := i + 1;
    end;
  write(number);
end
```

The description of the same solution written shortly:

```
begin
  number := 0;
  for i from 1 to n do
    if a[i] has the property V then
      number := number + 1;
  write(number);
end
```

After understanding algorithms working with one-dimension field students learn how to work with more one-dimension fields and then we start to describe creation of algorithms on matrices (two-dimension fields). The last lecture of the subject ALGDS contains explanation of the main idea of three simple sorting algorithms. With gained knowledge the students should to be able to describe them in full detail.

We made the above given illustration of the ALGDS-content for better understanding our approach to teaching this subject. Now let us introduce how we teach the subject ALGDS with help of the multimedia presentation and how the students can study it.

First we are going to speak about *full-time students*.

The number of students at FIM UHK who study ALGDS is about 200. It is quite a lot. The lectures take place in a big room using data-projector. There is no blackboard available. So *for the lecturer this means to prepare all needed material in the electronic form*. On the one hand we have our texts prepared in word-files and on the other hand we have nice multimedia presentation ALGORITHMS prepared in the software Macromedia Director 8.5 by one former student in his thesis. This presentation contains all algorithmic constructions described in the textbook [1] and also some examples. Its main advantage is its ability to illustrate and visualize some of explained algorithmic constructions. The disadvantage of the presentation is its impossibility to be completed with new algorithms. Therefore we also use prepared text in word-files that enables us to complete our lectures with other examples and make needed changes during the lecture in a similar way as using chalk and blackboard.

For the full time students it is not inevitable to use the multimedia program once they attend the lectures and seminars. But if they are ill or they decide to study themselves using the textbook than the program can help them to understand better the explained matter. The same applies for the *part-time students* who attend the combine form of studies.

The combined form of studies at FIM UHK means linking distance studies supplemented by consultations at sessions with teachers. Students prepare at home, using recommended literature, consulting and practising gained knowledge every fortnight with the teacher. This means 3 sessions for each subject they selected within one semester.

There is *WebCT virtual environment* available at our faculty. Students who study in combined form the subject ALGDS are lucky to have additional study material with the possibility of e-communication. In the WebCT environment they have important instruments available as e.g.: calendar and instruction how to study, possibility for communication with the teacher and other students, various self-tests and also tasks, which they have to send to their teacher for checking and evaluation. The prepared virtual

study environment enables them to use not only the recommended literature but also supplementary material as multimedia presentation ALGORITHMS by the means of which the topic is visualised. The presentation is highly appreciated by students. *Thanks to this system the students can study, as intensively and effectively as it they were full-time students*.

COMBINATORICS

Combinatorics is taught in the subject Discrete Mathematics, where we focus on three fields, closely connected with each other. These fields are Combinatorics, Graph Theory, and Graph Algorithms.

Combinatorics is strong equipment for increasing logical thinking thus we work hard with all concepts and solve a lot of practical examples. According to corresponding configurations (permutations, variations and combinations, and these with and without repetitions) we deal with tasks classified from the easiest to more difficult ones first. The next step is practising all these configurations in various examples.

After getting through the basic combinatorics configurations, we solve examples using the principle of inclusion and exclusion and the Dirichlet principle. Later, in the part of Graph Theory, students use the gained knowledge if they try themselves or learn how to determine the number of graphs with n vertices, to find out the number of various graph configurations, of which the most interesting is probably the determination of number of spanning trees in complete graphs and in complete bipartite graphs.

Almost two years ago two of our students developed in the software Macromedia Director 8.0 nice *multimedia presentations* called “Combinatorics” and “Combinatorics like a game”.

The program Combinarorics is a presentation, which consists of the explanatory part and the solutions of demonstrated examples to the given topic. There are six topics connected to the basic configurations. Each topic is divided into tree parts:

- explanation of the topic;
- solved examples;
- unsolved examples with references to their results.

Examples are lined up according to their level from the easiest to the most difficult.

The presentation Combinatorics like a game contains also explanation part and solved examples. Its main advantage is a lot of very nice pictures and animations with them the principle of inclusion and exclusion and the Dirichlet principle are explained there.

We use both presentations as a nice complement of our lectures; at the end of lecture *we repeat* the explained matter using nice visualizations contained in the mentioned presentations. At the seminars we use them too. Students try to solve not only in the program given examples, but also modifications of these examples put by teacher or a student. We always try very fairly to analyze each example and use different approaches to it, if possible. What is very important is the fact that each wrong answer must be explained either by the teacher or by the other students. Each student needs be aware what mistake he made and the teacher should know why his student’s thoughts went this way.

Both presentations Combinatorics and Combinatorics like a game offer to the students the possibility *to revise* the subject matter, which has been explained, and *to practise* it in examples.

Moreover the presentation Combinatorics like a game contains also information above the frame of the needed matter of the subject Discrete Mathematics. In this way students interested in the combinatorics *can increase* their knowledge.

GRAPH THEORY AND GRAPH ALGORITHMS

These fields are also part of the subject Discrete Mathematics at our university.

We devote big attention to them, because the creation of more complicated algorithms forms an inseparable part of the basic skills of our students whose specialisation is informatics. For them it is important to be able to think algorithmically and to gain wider and deeper insight into solution of the given problem. And it is graph theory together with graph algorithms, which enables them to formulate and illustrate a lot of interesting practical tasks.

When explaining graph algorithms we put emphasis on mutual relations between individual algorithms. On the one hand there are more algorithms which all can be used for solving the same task while on the other hand using effective modifications of one algorithms we can obtain other methods solving different tasks.

We have really illustrious program "Graphs" available. This program has been creating for more than two years by one of our students in the software Delphi in the frame of his thesis. His supervisor is the author of this article.

At present the program contains visualization of the following graph algorithms:

- Depth First Search
- Breadth First Search
- Tremaux Algorithm
- Tarry Algorithm
- Finding Euler Walk
- Finding the Minimum Spanning Tree by Boruvka
- Finding the Minimum Spanning Tree by Jarnik
- Finding the Minimum Spanning Tree by Kruskal
- Finding the Minimum Spanning Tree by dual Kruskal

Others have been developing.

The program provides the user with numerous possibilities of setting up the environment in which the presentation of the given algorithms runs.

Big advantage of the program Graphs, unlike the presentations, is the fact that there is the possibility to create a lot of other needed examples. Teacher can prepare several special graphs as e.g. complete graph, bipartite graph, Euler graph, Hamilton graph, etc., modify them and show all explained concepts on them.

Moreover teacher can prepare group of mutually related graphs, because the program allows opening more windows (see Fig. 1). Than it is easy for teacher illustrate all what is needed on more than one graph at once. Students have all these graphs also available and they can test there their in the subject gained knowledge.

This program is used *as useful complement in lectures* and students can run the program "Graphs" in WebCT environment, so it *serves as study materials* for them by their *self-study*.

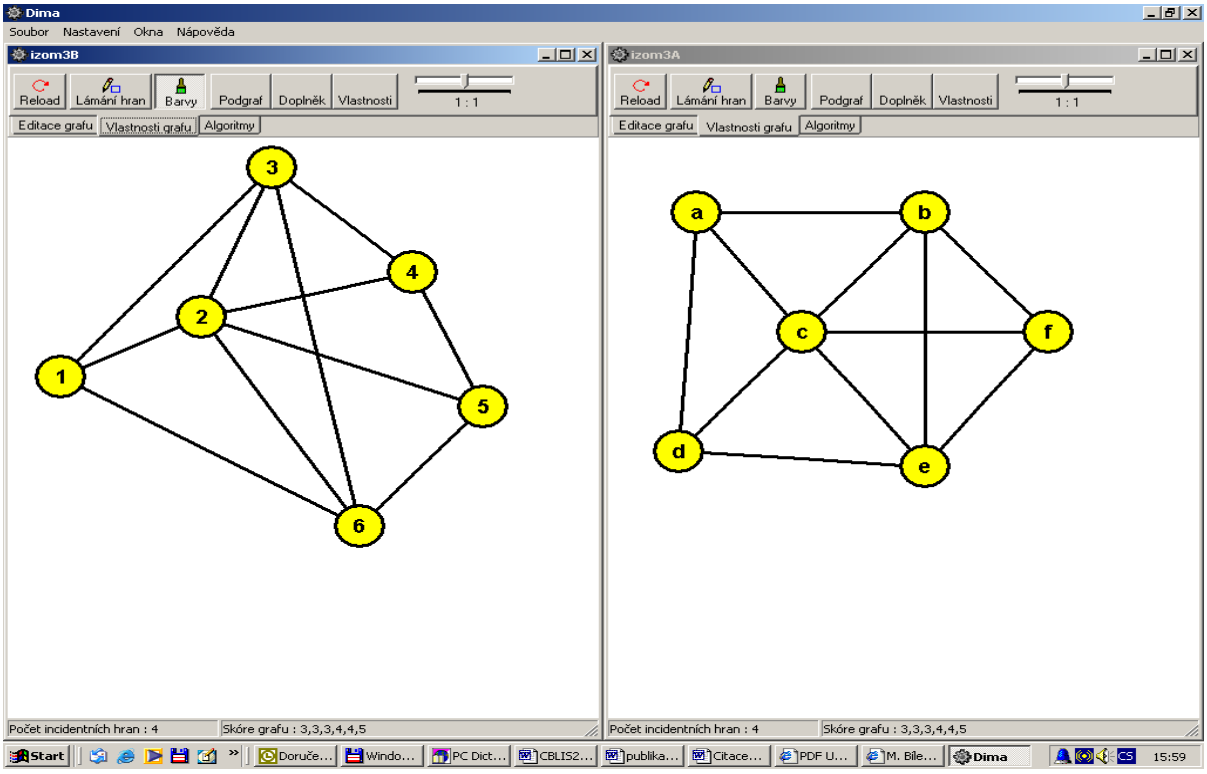

Figure 1

CONCLUSION

Newly formed information society requires a modern approach to education. A lot of teachers use the information and communication technology as useful complement of their lectures.

Visual presentations prepared with the aid of modern information and communication technology help to understand better all explained matters. Implementation of these presentations into the lectures makes them interesting, illustrative and understandable, and their location within the virtual study environment enables the students to get, to complete, to test and to deepen their knowledge.

Specific programs can be made with the help of students. It is nice when the students want to take part in creating such programs. These authors understand much better the thinking and needs of their colleagues, so they are good advisers in development of this software. Best reward for them is then to see their programs used in education.

Students find the Internet very handy when looking up things of their own interest. The teachers should take advantage of this fact and should try to create such conditions and such virtual study environment, which would enable the students to find all necessary study material there.

The teacher should try to change gradually the traditional way of teaching into modern educational process.

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Doc. RNDr. Eva Milková, PhD
University of Education
Faculty of Informatics and Management
Víta Nejedlého 573
500 03 Hradec Králové
CZECH REPUBLIC
Email: eva.milkova@uhk.cz