What Can Multimedia Add to the Optimization of Teaching and Learning at Universities?

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Abstract: Multimedia applications, an interactive system of digital media, where multimedia information is selected by the user himself according to his individual needs, give us an excellent chance how to support not only demonstrating and visualizing the explained subject matter to be much clearer and comprehensible, but also enable us to prepare such study material for students that optimizes their study habits. It means that makes their study more effective, time-efficient and explained topics more comprehensible. In the paper we present just a few ideas that have proved successful in teaching and learning with help of modern technology.

Key-Words: Multimedia study material, virtual learning environment, self-preparation of students, on-line testing

1 Introduction

“What is the new phenomenon allowing more straightforward expression of the subject matter? It is an interactive system of digital media, connecting multimedia information selected by the user himself according to his individual needs. It is a system based on interpersonal communication, which exploits sight and hearing and delivers adequate interaction and flexibility. Information within such a system can consist of different independent media such as animation, sound and video. Association of these elements together with interaction creates multimedia. Multimedia applications together with individual approaches within the didactic process have been becoming very important. The top applications of multimedia are represented by virtual reality.”[1]

There are large software products dealing with wide spectrum of objects developed by a team of professionals. However there are also various smaller programs dealing with objects appropriate to a subject created on a script given by the teacher with regard to students needs.

This paper illustrates especially advantages of smaller multimedia presentations and programs prepared for students studying in the full-time form of study. On a few examples of such multimedia products created by our students on a script given by the author of this paper we discus their benefit when explaining and visualizing the subject matter and testing knowledge of students through several kinds of self-tests.

At the end of the paper we also mention advantages of the professional virtual WebCT learning environment containing such study material.

2 Optimization of students’ study habits

Students find modern technology very handy when looking up things of their own interest. The teachers should take advantage of this fact and should try to prepare for them such multimedia study material, which would optimize their study habits. It means to create applications making students’ study more effective, time-efficient and explained topics more comprehensible.

When teaching a subject we always lay stress on applying the following principles so that our students, at least most of them, have entirely understand the explained subject matter.

Motivation to the topic

As a motivation to the given topic we often use puzzle. We let students solve it, discuss their solutions and after explanation of the appropriate subject matter we compare students’ solutions with an efficient solution based on the explained matter.

Teaching in contexts

We investigate a particular problem from more than one point of view if possible, modify a problem and discuss the mutual relationships among solved problems. In this way students are forced to think about each problem more than usually. By comparing the various attitudes the students are able to get deeper into the problem and to understand it. In order to enrich students’ view of discussed subject matter and deepen their awareness of it, we try to describe a particular problem on real life examples. We force our students to add their own examples describing the topic to be sure that they can understand it.
Visualization of the particular issue as well as it is possible

Demonstration and visualization make the subject much clearer and comprehensible. “Students need images and visualization in addition to words. Science learning is about creating images in mind, and teaching should support such image formation.” [2] We use created suitable multimedia applications as a complement of our lectures.

Intensification of students’ self-preparation

We try to prepare interesting study material for self-preparation of students to force them to study regularly as possible to be prepared for lessons. Lessons can be run more efficiently, like a discussion or consultation, then.

3 Multimedia Presentations

Multimedia presentations are usually used to describe a topic and illustrate it using visualization of objects and processes. They mostly enable to test the explained matter using several prepared exercises as well. Let us briefly describe two of several presentations used within the subject Graph Theory and emphasize their different usage.

Remark: The subject Graph Theory is a compulsory subject taught in the fourth term. Its aim is to develop and deepen students’ capacity for logical thinking. Students gain a basic level of competence in graph theory and graph algorithms. Well-prepared students in the area of graph theory and graph algorithms should be able to describe various practical situations with the aid of graphs, solve the given problem expressed by the graph, and translate the gained solution back into the initial situation.

3.1 Large Presentation - “Combinatorics”

The mathematical discipline combinatorics is strong equipment for increasing of logical thinking and students gain the basic knowledge in this area at the secondary school. In the subject Graph Theory we presume that our students are familiar with the basic combinatorial concepts. In the case that they need revise their knowledge, they have the presentation called “Combinatorics” created in the Macromedia Director environment by the student within his thesis available.

The presentation “Combinatorics” consists of the explanatory part (definitions, theorems and solved examples) and the solutions of demonstrated examples to the given topic. Examples are lined up according to their level from the easiest to the most difficult. The presentation also contains a collection of unsolved examples with references to their results.

3.2 Short Presentation - “Zoo”

The presentation “Zoo” is created in the Macromedia Flash environment by our student within his bachelor work. It explains and illustrates step by step how to find Euler trail using the Edmonds-Johnson approach. The method is applied on the practical example how to walk whole zoo.

With help of this presentation students can briefly revise the topic when it is needed. Students who miss the lecture can use it as a useful complement of the printed study text.

3.3 Summary

The first presentation offers students the possibility to completely revise the large subject matter. The second presentation serves as detailed visualization of the given topic explained within the lecture.

4 Multimedia Programs

Biggest advantage of the programs, as opposed to the presentations, is the fact that there is the possibility to create an infinite number of needed examples. At first let us devote attention to the illustrious multimedia program “Graphs” [3] used also within the subject Graph Theory (see the chapter 3). Than we briefly introduce another program used within the subject Algorithms and Data Structure (see thereinafter).

4.1 Program “Graphs”

The program “Graphs” was created in the Delphi 5 environment by our student within his thesis. The main purpose of this application is a visual representation of basic graph-concepts and graph-algorithms using a colouring process on graphs created within the program.

The program enables creating new graph, editing it, working on it (moving, colouring vertices, edges, etc.), saving graph in the program, saving graph in bmp format. It allows opening more than one window (see Fig.1 thereinafter) so that two (more) objects or algorithms can be compared at once.

Thus the program “Graphs” enables the teacher to complete his/her explanation within lectures, the possibility to open more that one window enables him/her to explain the problem from more points of view and show mutual relations among used concepts, algorithms. The possibility to safe each created graph in bmt format using colours allows the teacher easy insertion of needed graphs into texts and presentations (see the following example used as a motivation to the concept graph, and the figures Fig.2 - Fig.4).
Example

An international company opened five positions for translators from the following languages: Russian, German, English, French and Portuguese.

Five candidates apply for the job.

- Mr. Smith can speak all 5 languages;
- Mr. Parker can speak English, French and Russian;
- Mr. Thomas can speak German and Russian;
- Mr. Brian can speak English and German;
- Mr. White can speak Russian and German.

Is the company able to provide all opened positions so that each candidate would translate just from one language? If it is possible, propose the solution.

Solution

The situation can be easily represented by the following graph.

Looking at the graph it is obvious that the vertex \( S \) must be connected with the vertex \( Sm \), thus at first the we color the edge \( \{S, Sm\} \) by red color and the other edges incident with the vertex \( Sm \) by blue color (to reject them). Then the edge \( \{F, Pa\} \) we denote by red color and the other edges incident with the vertex \( Pa \) by blue color, etc. Finally, red edges represent two possible solutions (Fig.3 and Fig.4).

Using the program “Graphs” students can revise a lot of subject-matter within the area of graph theory. They can use not only graphs prepared by the teacher but also their own graphs and explore the properties of these graphs. The possibility to open more than one window enables them to follow mutual relations among used concepts and algorithms. The option “Save Graph in bmp format” enables them easy creation needed graphs for their assignments where describe various practical situations with the aid of graphs and solve the given problem.

4.2 Program “Algorithms”

The program “Algorithms” is prepared for the subject Algorithms and Data Structures which is a compulsory subject taught in the first term. The aim of the subject is to develop logical thinking of students, teach them to create simpler algorithms and to understand more difficult ones. Algorithms are written in the Czech meta-language. Students write them on paper. The subject is placed before the other subjects dealing with algorithmic and programming skills.

Because students have been forced to write their algorithms on paper there was an important question: “How can students get feedback for their solution written on paper in the Czech meta-language (Czech transcription of pseudo Pascal - the basic commands) when studying at home and preparing for lessons?”

Of course, they have two books ([4], [5]) containing many solved examples, prepared for the subject Algorithms and Data Structures, available. Nevertheless, there are a lot of other tasks that we give our students to solve. This was the main reason, why the program “Algorithms” [6] was created. It was developed in Borland Delphi environment within the thesis. The program is user friendly and provides entire graphical comfort for users.

Using the program “Algorithms” students can place their solution (algorithm written in the Czech meta-language) of the given task in the program and the program shows them step by step how their algorithm work, if it is correct or not. The program also shows actual values of used variables in each step of the algorithm’s process.
The program is not only a substantial help to students in their self-study but it helps also teachers to prepare text materials (lectures, tests etc.).

4.3 Summary
The program “Graphs” enables the teacher to complete his/her lectures in the way that explained topics can be more comprehensible.

Both programs save the teacher’s time very much when he/she prepares text materials and presentations.

Using these programs students can revise explained subject-matter and deeper understand it. They can very easy prepare their assignments with the aid of programs as well.

Students studying the English study program at our faculty can also use both programs because it is possible to localize them into English language.

5 On-line self-testing
“The feedback provided through tests has helped students to recognize what they needed to know, appreciate what they already knew and understand, what they needed to do in order to learn, and what they didn’t know” [7]. Our students can test their knowledge using programs described in the previous text. However they have various other possibilities how to do it. At our university we have been using the professional virtual WebCT learning environment for several years. Among WebCT tools there are also tools enabling to prepare tests.

5.1 Tests in the WebCT environment
There are three kinds of on-line tests in the WebCT environment in the option called Assessments: Quizes, Self tests and Surveys.

A quiz is an online test that students complete and submit for marks. The marks are recorded in Grade Book. (Remark: Grade Book is the WebCT tool that serves to the teacher to view, enter, and manage grades for students.) Quizzes are used to assess students’ knowledge within the given subject.

A survey is an online questionnaire that students complete and submit anonymously. It allows students to give feedback or opinions.

A self test is an online test that students complete and submit for marks so they can assess their understanding of study material. However, the marks are not recorded in Grade Book.

In the classical (non electronic) tests prepared to test knowledge in natural science subjects there have been used two main types of questions for years (centuries); the type Calculated and the type Multiple Choice. However, in the textbooks directed to the education of foreign languages there have been used several other types of questions even those that give a chance to solve tasks in an enjoyable way. These types are available in the WebCT environment as well and we tried to use all of them when preparing test-questions for the subject Graph Theory. Let us introduce their list and short description.

**Calculated**: Students are presented with a mathematical formula and must enter the answer.

**Combination Multiple Choice**: Students are first presented with a list of answers. They are then presented with various combinations of those answers and must select one of the combinations as correct.

**Fill in the Blank**: Students are presented with a question containing blanks and must provide the missing text.

**Jumbled Sentence**: Students are presented with a question containing blanks for which they must provide the missing text by selected word or phrase from drop-down lists.

**Matching**: Students are presented with two lists and must match terms in one list with terms or definitions in the other list.

**Multiple Choice**: Students are presented with a list of answers and must select one or more answers as correct.

**Paragraph**: Students must answer the question by entering multiple sentences.

**Short Answer**: Students must answer the question by entering a brief response.

**True False**: Student must select whether the statement is true or false.

It is very important that the WebCT environment enables to include figures (see Fig. 5) and tables within the questions. Without this possibility it would be unthought to create questions for the subject Graph Theory based on images of graphs.

![Combination Multiple Choice question](image)
We do not use on-line testing as a part of examinations. The prepared tests serve for students to recognize themselves what knowledge they need still to improve. Students can, but don’t have to solve them during the term. However, similar tasks occur in the exam test. It is up to the students whether they deal with these questions and if they do not understand them well they can discuss them with their teacher during the lessons.

The types of questions prepared by WebCT tool need not be easy to fulfil for each subject. In the following text we illustrate two different applications used for testing students’ knowledge partly within combinatorics and partly within algorithms.

5.1 Webpage “Tests with Help”
The tests denoted as “Tests with Help” are intended for testing knowledge of our students within combinatorics. It is created as a webpage and the link to it is placed in the WebCT environment within the subject Graph Theory.

Students select a part of combinatorics (permutation, variation or combination with or without repetition) at first. Clicking on the selected part they can see several tasks. They start to solve them. Next to each task there are three buttons: First help, Second help, and Whole solution. If they are helpless when solving the task they click on the First help to get first advice. If they are still helpless they click on the Second help. The button Whole solution serves them as checking if their solution is correct or as the total help.

5.2 Web application “algds”
The application “algds” [8] is created in PHP language and it is intended for testing knowledge gained in the subject Algorithms and Data Structure (see section 4.2).

The application enables three types of questions:
Complete the given algorithm
Order the given algorithm
Solve the given algorithm

The test Complete the given algorithm demands to complete omitted parts in the algorithm solving the given task as e.g.:

Complete the algorithms solving the following task.
"In the sequence of n integers saved in the array a (in items a[1] , ..., a[n]) determine the first minimum value and then sum of all integers behind the found minimum value."

begin
    minimum := a[1];
    sum := .......
    for i := 2 to n repeat
        begin
            sum := sum + .......
            if a[i] ≤ min then
                begin
                    minimum := ......
                    sum := ......
        end;
    end.

The test Order the given algorithm demands to order all commands written in wrong order to get algorithm, which correctly solves the given task.

The test Solve the given algorithm demands to determine values of some variables used in the algorithm using the given enter data as e.g.:

"There are n integers saved in the array a (see the table). Determine the values in the array a after finishing the following algorithm. Write them to the table."

begin
    n:=6;
    x:=a[1];
    i := 2;
    while i ≤ n - 1 do
        begin
            if a[i] > x then
                begin
                    a[1]:= a[i];
                    a[i]:= x;
                end;
        end;
        i := i + 1;
    end.

end.

Figure 6: Design of the application “algds”

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>8</td>
<td>19</td>
<td>7</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>
The link to the application is placed in the WebCT environment within the subject Algorithms and Data Structures.

The Web application “algds” enables students to improve their knowledge in an enjoyable way. Each student’s answer is analyzed and the correct answer appears if student was wrong. There is no explanation of why the student’s answer was false however they can follow step by step the whole algorithm using the program “Algorithms” (see section 4.2).

6 Virtual learning environment

As we have mentioned at the beginning of this paper the top applications of multimedia are represented by virtual reality. At our university the professional virtual WebCT learning environment has used.

At the end of this paper let us briefly summarize how can virtual learning environment used as a compliment to subject influence the optimization of students’ study habits. [9]

- Students have all electronic study materials assigned to the appropriate subject available altogether in one environment together with needed information.
- Students greatly appreciate accessibility to self-tests with automatic checking and to multimedia study materials visualizing the explained matter.
- The relevant study material is accessible whenever and wherever. In this way also students staying abroad within the framework of students exchange for several months are able to follow the subject.
- Students interested in the area explained within the subject can find additional material in the WebCT environment, and sources and information outside the immediate framework of the subject. Discussions on “a level” with their teacher can start. This is also one of the ways in which the teacher can train his potential thesis writers.
- In many subjects, the inevitable outcome of creating common projects is teamwork. Virtual study environments are inherently well-suited to this. Students can communicate with the teacher and each other, and discussions are accessible to members of the team only.
- Students find also very useful the possibility to find all the information about important dates (written credit tests, examination etc.) and evaluation of their work within the subject in one environment.

7 Conclusion

In our paper we discussed what multimedia can add to the enhancing of teaching and to the optimization of students’ study habits. We have shown how important and effective can be role of multimedia study materials as a complement of lectures on one hand and as important support of students’ self preparation on the other hand. We also mentioned how multimedia programs can save the time of both, teachers and students, when preparing the other study materials.

Let us emphasized again that visual presentations prepared with the aid of modern information and communication technology help to understand better explained matters and implementation of them 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 and increase their imagination.

Students admire quality multimedia applications prepared by their colleagues. These materials inspire them and we are pleased to see the increased interest not only in the subject matter but also in the cooperation by preparation of the other multimedia material.

References: