E-Learning Materials for 3rd Grade of Primary School - Physics

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***Abstract*—It is very important for the development of natural science competences of children to choose the right approach to teaching the physics. E-learning materials developed so far are a useful addition to the learning process. Their function is to assist in explaining the real world around us. Among other goals, this means the explanation of experiments and preparation to conduct them. In the frame of our national project we have prepared the e-learning materials which cover the basics of physics for primary school pupils. Children are encouraged to study the materials and conduct their own experiments. Teachers who have used our materials are giving us very encouraging responses and would like to use other learning materials prepared in this way.**

***Index Terms*—E-learning materials, physics, primary school**

I. INTRODUCTION

One of the problems in primary school subjects relating to natural sciences is the steady decrease of the level of both teaching and consequently the knowledge acquired by pupils. In order to solve this problem, appropriate didactic strategies are searched for. On the other hand, it is obvious that the children are fairly susceptible to acquiring experimental skills [1] as well as learning from ICT (Information Communication Technology) sources, such as computer web pages. Therefore, combining experiments with ICT may be a very successful way of learning natural sciences to a satisfactory depth. E-learning materials have been created on web pages to achieve the desired combination experiment/ICT, at least for natural sciences [2].

E-learning materials have also been prepared for social sciences. Here, we focus on natural sciences, more specifically on subjects from physics for the 3rd grade of primary school. At this level, physics is not a separate school subject, but its topics are the part of the subject named Environmental education. The corresponding competences of pupils which development should be started or continued at this level, are, for instance: 1) successful reading the scientific stuff, 2) ability to find appropriate ICT sources, 3) developing the skills for contemporary learning techniques, 4) inter-disciplinarity, 5) advance in understanding the subjects at least up to the comparison level, i.e., the ability to compare qualitatively or even quantitatively the values of certain physical quantities.

In this paper we describe the successfulness in attempts to use physics e-learning materials developed by our institution in school practice [3]. Furthermore, we discuss the limitations in the use of this method, as well as our plans, how to circumvent these difficulties.

II. E-LEARNING MATERIALS – TOPICS FROM PHYSICS

At the moment, there are 6 topics in e-learning materials for 3rd grade in connection with physics. They cover all didactics goals prescribed in the national school plan for this level. The topics are presented by various means: figures, sound, films, explanation text, motivation questions and interactive knowledge tests (interactive elements), see Figure 1. The amount of different kinds of presentation techniques depends on the specifics of different topics, as shown in Table I.

There are two operational goals of the physics experiments guided by e-learning materials:

1. To guide teachers and pupils to repeat the presented experiments in equal way.
2. To encourage them to perform their own variants of the experiments.

Of course, in both cases, the main didactic goals mentioned above are followed.

The representation structure for all topics and experiments is the same. Each topic is divided into sections corresponding to the learning goals. There are several explanation text boxes, presentations of different kinds (sound and video animations video films, images). There is also a mascot – the owl that personifies the wisdom – who leads the pupil through the e-learning process. Furthermore, there are other common icons which activate certain actions, for instance the icon for the action "discover", which encourages the pupil to see what will happen in some natural phenomenon. There are also interac-

TABLE I.
NUMBER OF ELEMENTS IN PHYSICS CONTENT TOPICS

	NUMBER OF						
TOPIC	sections	text boxes	images	animations	video films	audio's	interactive elements
movement	3	14	3	6	3	0	3
light	6	17	51	1	7	0	13
sky	2	7	0	0	2	0	2
weather	3	10	34	0	4	0	9
sound	7	18	47	0	5	11	19
time	6	15	54	0	1	0	22
average per topic	4,5	13,5	31,5	1,2	3,7	1,8	11,3
summarized	27	81	189	7	22	11	68

tive elements which test the pupils' understanding of the topic contents through the learning process. The final knowledge test is provided for each topic.

We give a brief description of the experiments and the desired goals for each topic.

Movement (kinematics). This topic is divided into 3 sections: 1) movement under the influence of forces, where the cases from statics and dynamics are considered; 2) movement of the objects through the air; 3) movement in water. In the last two sections the medium resistance to movement of the objects is exploited, together with practical aspects. For instance, the use of air resistance for the parachutes is described.

Light. There are sections about light sources, direction of the beams, observation of illuminated objects, reflection of light, the functioning of the eye and shadows.

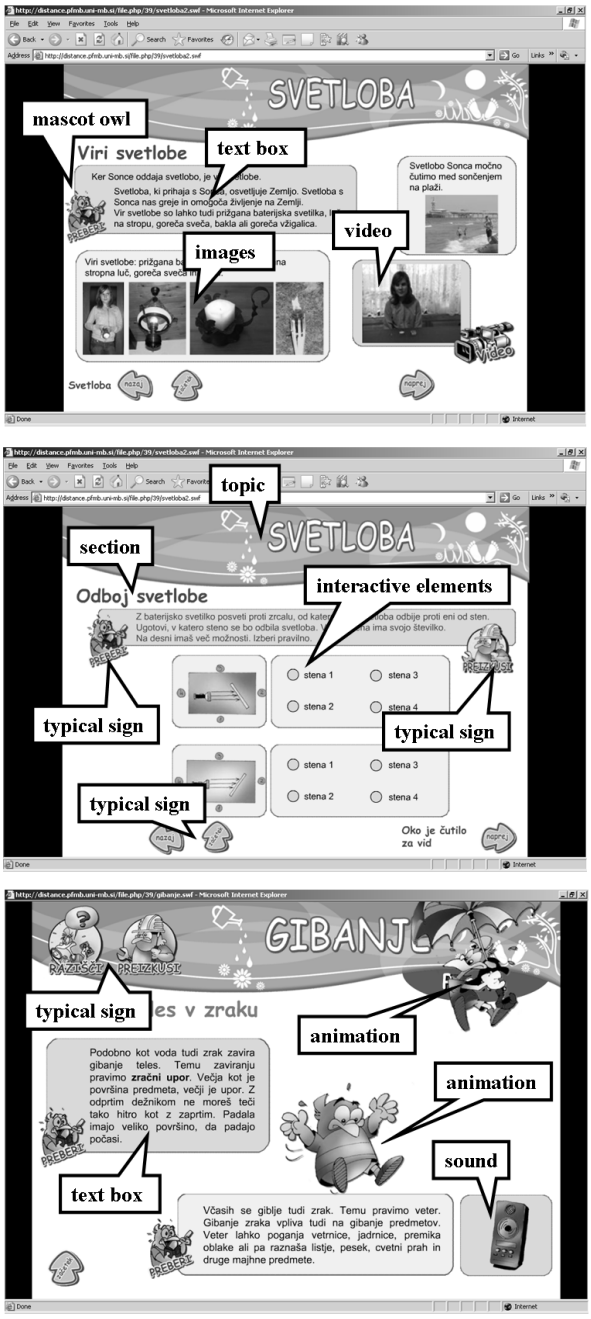

Figure 1. Typical screen elements in topic presentations

Sky. There are two sections: 1) apparent movement of the sun; 2) night sky. In the first section the cause for the apparent movement of the sun and the change of day and night is explained. In the second section the moon and the stars are described.

Weather. In the three sections the weather characteristics (temperature, humidity, wind, rain, snow, etc.) and the weather prognosis are described, and the measurement of the wind speed and direction is particularly stressed. The last section is connected to the wind energy as one of the alternative energy sources.

Sound. This topic which is divided into seven sections, may be the most interesting to the pupil. It describes many aspects of sound in everyday life, for instance, the working principles of musical instruments.

Time. From the physics point of view this is probably the most important one of the six topics. Time is the parameter (or variable) which appears in all physics branches. For instance, it is important for the pupils to understand the connection between the passing time and the sequence of events. Time is also the basis for definition and description of very important and broad physical concept current/flow (flow of particles, mass, energy, heat, electric charge, etc.), which also interconnects physics and other natural sciences.

III. EXPERIENCE IN USING E-LEARNING MATERIALS

A. *Pupils*

To our knowledge, pupils start using e-learning materials not earlier than in the highest classes of primary school or even later – in secondary school. By our opinion, this is much too late. E-learning materials could be most helpful as early as in the 3rd class of primary school. There are two reasons for our claim: 1) Pupils meet some physics subjects in school at this level already, 2) According to investigations in psychology [4] many children at this age just become able to gain the understanding of basic continuity concepts characteristic for physics/mathematics (for instance, independence of the volume of definite amount – mass of water of the shape of container). Thus, skipping the use of e-learning materials appropriate for this level could mean missing the important stage in pupils' development in understanding some general natural science concepts. Some efforts have been already laid in the development of other software tools [5] for learning of natural sciences contents, adequate for 4th or 5th grade, which served as a good example for constructing materials presented in this contribution.

B. *Teachers*

We have conducted a preliminary didactic experiment with primary school teachers (teaching topics from physics) on the use of e-learning materials (6 topics described above) [6]. There was no cooperation of pupils at this stage. At the end of the course teachers wrote seminar texts on preparation and performation of e-learning technique within a school lesson; any of the 6 topics described above could be used. The response of teachers on the experiment on e-learning materials was very positive. Among their positive comments we mention the following ones:

1. It is encouraging that someone at all started work on developing e-learning materials for this level [7,8].

2. The principles of modern didactics are appreciated in this technique.
3. Teachers are constantly forced by pupils, their parents and the school manager to use ICT more frequently. Therefore e-learning materials are helpful for them.
4. Teachers for this level have commonly too shallow and loose knowledge of natural sciences and also have too few ideas for various interesting experiments and thus e-learning is a good guide for them.
5. A good set of multimedia elements is given in e-learning materials.
6. All pedagogic goals can be fulfilled with additional help of e-learning; for instance when the weather is bad and prevents some experiments in nature, there is at least a corresponding simulation on web page.

C. *Teachers and pupils*

In subsequent didactic experiments teachers first learned about e-learning materials, and then they used them in practice, in their classes. Three main conclusions were drawn:

1. Pupils were enthusiastic about conducting experiments by following instructions of e-learning materials.
2. The acquired knowledge was not satisfactory since they didn't work systematically.
3. The textual explanations seemed to be too lengthy in regard to reading skills of pupils.

Consequently, the need for slightly smaller pupils' self-initiation and more organized teachers' guidance became evident. Teachers themselves appealed the need for additional courses in e-learning materials, so that they can be more self-confident in leading the classes with this technique. In particular, the explanation texts on web pages should be shorter, and the teachers should give oral explanation of the topic and experiment instead. Now, the project on revision of the e-learning materials according to the teachers' recommendations is going on.

Finally, a list of some possible pupils' direct interactions with the e-learning materials as well as parallel activities at school in general (depending on their maturity and available time) is given:

1. Trying to answer the teacher's problem-solving question in connection with the specific e-learning topic before the e-learning session. This is good for pupil's motivation; the question should be such that most pupils are able to solve it at the end of the e-learning session.
2. Careful reading explanation textboxes, in order to understand the text completely.
3. Answering the test questions before and after conducting a simulation/animation of natural phenomenon. Checking the acquired knowledge in the final topic test.
4. Discussing the topic and in particular the correct answers to questions with each other.
5. Careful watching the film of the experiment and repeating it in reality, either in an equal way or with some modifications. Modifications are fruitful since they develop the pupils' imagination and motivation.
6. Evaluation of specific topics and e-learning activities (strongly recommended) and making their own list of ideas and wishes of what the e-learning materials could also include. The teacher could forward these suggestions to the teams that develop these materials.

IV. CONCLUSIONS

We have found that the six physics topics from the e-learning materials concerning the 3rd grade of primary school can be an appropriate and interesting way of improving the pupils' understanding the basic concepts of natural sciences. In order to accomplish this, existing contents on web pages have to be revised slightly, mostly as regards the length of explanation text. Furthermore, there is a need for additional courses for teachers in using these web pages.

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