Teachers' experiences and recommendations about using E-learning Materials in Primary School

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Abstract. *The use of computers and web pages has become an inseparable part of contemporary life and also increasingly popular at all levels of education. Developed e-learning materials may be an interesting addition to the learning process, in particular for natural sciences. In the frame of our national projects we have prepared some primary school physics topics in the e-learning materials. Prepared materials help pupils to conduct experiments and encourage them to try different variations. Teachers who have tried our e-learning materials in their school practice were very satisfied and they expressed the wish for other physics topics prepared in this way. In addition, they suggested some minor changes in the representation of these materials. We have come to conclusion that in the future preparation of e-learning materials, we should closely cooperate with teachers, programmers, psychologists, pedagogies, etc., as well as didactics of natural and computer science.*

Keywords. E-learning material, physics, primary school.

1. Introduction

Distance-learning materials on web pages are nowadays widely extended. Electronic encyclopedias such as Wikipedia cover every scientific topic one can imagine. In addition, the computers have become a usual part of everyday life and even very young children often come into contact with them. In order to enrich the learning process, appropriate didactic strategies are searched for and various contemporary tools are used in the school. In the case of natural sciences (or their topics in more general school subjects), pupils' experimental practice should always occupy the first place in their first experiences with science. 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. Appropriate combination of experimental work and ICT is thus a promising way of learning natural sciences and also gives opportunities of inserting of modern scientific knowledge in the teaching of elementary physics [2-4].

The European documentation about ICT competences shows quite different points of view and demands in different countries. While in some of them the desirable level of ICT knowledge is the "Computer driver license", all computer-science elements including algorithms and programming are included in general education in other countries [5]. ICT competences at school can be classified into three levels:

1. ICT fundamentals
2. ICT theory and practice
3. ICT application

Of course the third level of knowledge is desirable. The position of Slovenia among other countries in ICT education is good. E-learning materials in Slovene for primary school level have been created on web pages both for social and natural sciences. For the latter, an important part of these materials are visualizations and explanations of real experiments [6].

Here, we focus 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 [7]. Some corresponding competences of pupils could be successfully trained at this level, from reading the appropriately presented scientific literature to developing the skills for contemporary learning techniques. In this context, we also mention general competences (GC) of individuals which are defined in various ways, but in essence they mean combinations of knowledge, skills, habits and emotional components which are necessary for different life and learning tasks. In the frame of the running national project "Development of natural-science competences" [8] the following list of GCs (also important for natural sciences) according to the report of Mayer committee [9] was accepted:

1. Ability of collecting information
2. Ability of the analysis of literature and organization of information
3. Ability of interpretation
4. Ability of the synthesis of conclusions
5. Ability of learning and problem solving
6. Transaction of theory into practice
7. Usage of mathematical ideas and techniques
8. Adaptation to new situations
9. Care for the quality
10. Ability of individual and team work
11. Organization and planning of the work
12. Verbal and writing communication
13. Inter-personal interaction
14. Safety

It is not difficult to see that the e-learning materials (including real experiments) stimulate most of the mentioned GCs, thus they are a good support to the national project. In this paper we describe the successfulness in attempts to use physics e-learning materials developed by our institution in school practice [10]. Furthermore, we discuss the teachers' suggestions and recommendations about improving some points of these materials.

2. E-learning materials for 3rd grade of primary school

There are six physics topics in e-learning materials for 3rd grade; movement, light, sky, weather, sound and time. The presentation of the topics is diverse: it includes photos, drawings, sound, animations, films of the truly conducted experiments, explanation text, motivation questions and interactive knowledge tests (interactive elements), see "Fig.1.". The amount of different kinds of presentation techniques depends on the specifics of different topics, as shown in Table 1. The experiments are presented so evidently that the pupils should have no trouble in repeating them even if they work completely without teacher's guidance. But perhaps the teacher could encourage them to design and try their own variants of the experiments. This would strongly stimulate pupils' motivation, experimental skills and some of generic competences.

Table 1. Number of elements in physics content topics. The table is taken from ref. [11].

	NUMBER OF						
TOPIC	Sections	Text boxes	Images	Animations	Video films	Audio	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
Stand. dev.	2,1	4,2	24,2	2,4	2,2	4,5	8,2
Summarized	27	81	189	7	22	11	68

The representation structure for all topics and experiments is the same. Each topic is divided into sections (the number of sections for each topic is given in Table 1). The pupil is led through the e-learning process by a mascot (owl) who personifies the wisdom. There are many other common icons which activate certain actions. More details about the topics and their representation were given in our previous paper [11]. Since the present e-learning materials are the first stage in their development, the interactive elements and final tests are relatively short and incomplete. We have ideas to supplement them with several additional questions in future, in order to cover the entire scale of the knowledge quality according to Bloom's taxonomy, from the lowest level of recognition/comprehension to the highest level of evaluation [12].

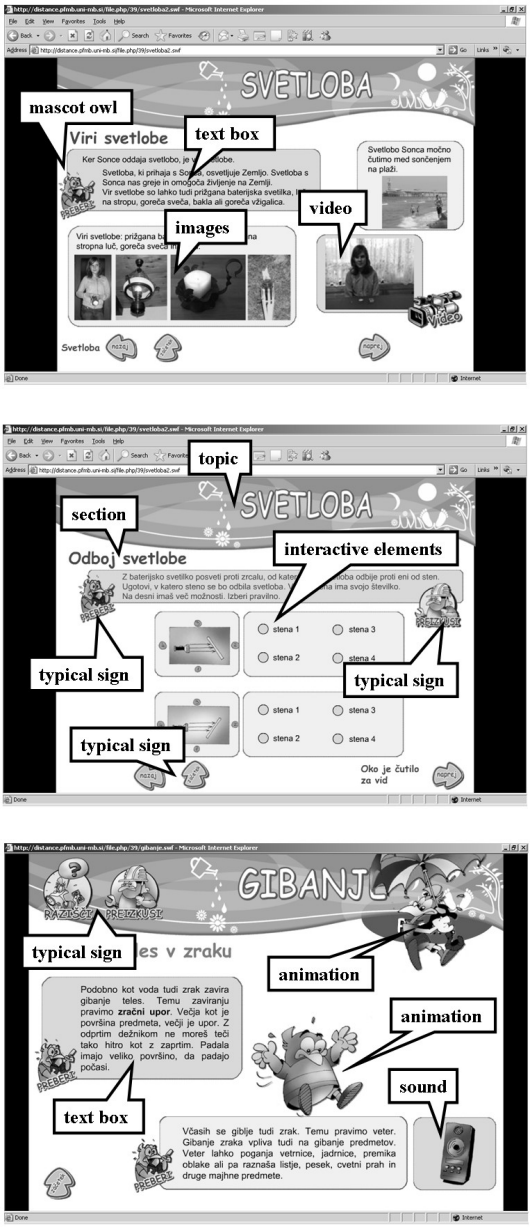

Figure 1. Typical screen elements in topic presentations. The figure is taken from Ref. [11].

3. Time and organization plan of the development and testing the e-learning materials

In the frame of previous national project [13] our e-learning materials were made in the period from October 2007 to April 2008. They were tested (all the topics, not only physics and natural sciences) by primary school teachers from selected schools in June. The teachers first learned about e-learning materials, and then they used them in practice, in their classes [11,14]. 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.

These findings were partially appreciated and the materials were revised till the end of September 2008 when the project was officially closed. The e-learning materials were subsequently released for the common use on internet. We continued with the informal collecting the opinions and recommendations of the teachers who used the prepared e-materials in school practice via the internet link. We decided to conduct an additional experiment in the period February to March 2009; this time only with primary school teachers on the use of e-learning materials, with six physics topics listed above. We have chosen the teachers of the subject Environmental education in the 3rd grade of primary school which contains the 6 topics. The selection of cooperating teachers was done according to the following criteria:

- Affinity to natural sciences
- Affinity to ICT and use of e-learning materials
- Ability of doing two teaching principles simultaneously: frontal work and observation of pupils' responses: activity, motivation, following instructions, inventiveness, answering the test questions, etc.

According to these criteria, 10 teachers were selected from the north-eastern part of Slovenia. Since each teacher performed the test with his own class, 176 pupils, i.e., about 1% of the Slovene generation in the 3rd grade, were included. After the school didactic tests we had discussions with teachers about the successes and limitations of using this teaching technique. The teachers' opinions were also based on some quantitative measuring techniques in educational experiments. The teachers and pupils were from 10 different schools in the city or near-city area.

The findings of these educational experiments will be used in the new national project on e-learning materials which already started in May 2009 (see Acknowledgements). Our task in the new project is the upgrade of the four existing e-materials for 3rd grade: our own and three others.

The plan in the national vision of building the e-learning materials seems to consist of three phases. In the first phase (previous national project) the materials were built separately. In the second phase (running project) different topics will probably go toward unification in presentation philosophy since one developing group works on more materials. In the third phase, the internet portal with e-learning materials will be probably created. We think that the possible inclusion/connection of this portal within the wider Slovene portal SIO [15] would be a good idea.

4. Teachers' comments and recommendations about the use of e-learning materials

The teachers' comments and recommendations (with regard to 6 physics topics in the subject Environmental Education) were the following:

1. All the mentioned 6 topics should be partially covered by e-learning materials in a suitable way: either by performing the experiments suggested by materials (without going through all details in materials), or just using the e-materials while other experiments (not those in e-materials) are conducted, or doing both (going through all the reading, simulations, animations and tests in the e-materials and conducting all described experiments).
2. Using e-materials is an excellent variegation of school lessons with no extra expenses.
3. The problem appears if the school is equipped with too few computers. If the pupils sit at computers in pairs, all of them should take equal effort. The positions of the pupils in pairs must be exchanged, so that every pupil does some typing on computer keyboard instead of being bored and just watching what his/her partner is doing. It's not good if the abilities of the pupils in the same pair are too different.
4. If some experiments or observations in nature cannot be done for objective reasons (e.g., bad weather when the experiment with the sun light is to be done) the e-materials can serve as an appropriate substitute.
5. It is quite difficult for the teacher to simultaneously take the overall control in the classroom and help individual pupils (either in understanding the text or user operations in e-materials or in performing the real experiment) because of different pupils' abilities. Therefore, at least a part of the teaching with e-learning materials must be in a frontal form. The frontal work is also more appropriate for checking pupils' answers in tests in e-materials.
6. All the described experiments (at least in physics) can be performed at home with no particular danger or demands, so that the curious pupils can be satisfied. The internet access to these materials is free and there is no need for the username, the help of system administrator and similar.
7. Some topics are appropriate not only for 3rd grade but also for lower or higher classes, from 1st to 5th grade.
8. E-materials are very convenient to use in the case of teacher's supply (i.e., when the class teacher is absent), particularly when the supplementing teacher who teaches some other special subject in higher classes is not familiar with natural sciences.
9. It would be a good idea if two teachers of the 3rd classes at the same school cooperate in some kind of exchange of classes in the following way. Each of them takes three of the six physics topic and presents them with e-learning materials in both classes. This would be probably interesting for pupils. This would not be against the rules because this would only a part of adopting the material, not evaluation of pupils.
10. It is fortunate that the printed textbook exists for this subject in 3rd grade. So the pupil who does not have the access to internet at home and thus cannot use the e-learning materials is not too deprived. He can learn everything from the printed book.

The teachers were also aware of the dilemma of using either the usual classroom (equipped with one computer) or computer room for teaching with the help of e-learning materials. This dilemma deserves a special consideration in this paper. Both rooms have advantages and disadvantages. For instance, every pupil can work with the computer in computer room but there is often too little space for experiments in this room which poses the problem of both convenience and safety. In the usual classroom, the work with the computer must be done frontally by teacher and therefore the darkening of the room must be done, so that the pupils' experiments must be performed after teacher's presentation when the room is brightened again. There may be also the problem with the working method depending on the contents of the topic. For instance, it seems awful for the pupils to simulate sound animations of the music instruments in the topic "sound" when all of them do this on several computers: this would be quite noisy. A solution to this specific problem might be the used of headphones but this would present health considerations.

The table was prepared for teachers in regard to the use of all 6 topics of e-learning materials according to the working place and way of work (individual or frontal). The teachers had to answer "yes" or "no" for each table window, according to their opinion if the presentation of the specific topic seems to be appropriate enough. In this paper Table 2 represents the number of positive answers (from 0 to 10) of all 10 teachers.

Table 2. Number of positive answers about performation convenience for different topics.

TOPIC	Exp. in usual classroom	Exp. in comp. room	Exp. outside	Frontal e-mat.	Individual e-mat.
movement	10	6	5	8	5
light	10	5	2	8	7
sky	5	0	8	6	7
weather	5	0	9	5	7
sound	7	0	4	6	2
time	10	10	5	8	4
average per topic	7,8	3,5	5,5	6,8	5,3
Stand. dev.	2,5	4,2	2,6	1,3	2,1

The meaning of the abbreviated terms in the table:

- Exp. in usual classroom: is the conduction of most real experiments in the topic suitable in usual classroom?
- Exp. in comp. room: is the conduction of most real experiments in the topic suitable in computer room?
- Exp. outside: is the conduction of most real experiments in the topic suitable outside the classroom, in nature?
- Frontal e-mat.: Is the frontal work with e-learning materials on the computer appropriate for the topic?
- Individual e-mat.: Is the pupils' individual work (or work in pairs) with e-learning materials on the computer appropriate for the topic?

The aim of Table 2 was the evaluation for each topic, what location is partially or completely more suitable for the lesson with e-materials: usual classroom or computer room, or conduction of experiments outside. The use of different locations/methods is not exclusive: for instance, some or most experiments may be conveniently done in both usual classrooms and computer rooms. Of course, the option frontal work on computer supports the use of usual classrooms, while the option individual work supports the use of computer rooms. It follows from Table 2, that at this stage in the development of e-learning materials it is more appropriate to use the usual classroom, where the teacher goes through the text of materials frontally and after that the pupils conduct the experiment.

5. Conclusions

Additional didactic tests on 6 physics topics of e-learning materials for the 3rd grade of primary school were conducted and about 180 pupils were included in the tests. Valuable findings about the contents, design and didactic concepts of materials, as well about equipment and appropriate location for successful use of these materials were obtained. Teachers also gave recommendations about the strategies in the using of e-learning materials, i.e., the convenient didactic methods and some organizational aspects. The part of materials including natural sciences and particularly physics topics was treated with appreciation. The building and supplementation of these materials is being done in phases. The final vision is development of the educational web portal. It also became evident from our experience that the close cooperation of nature-science experts, didactics experts, teachers, programmers, psychologists, pedagogies and support technical team (designers, photographers, etc.) is very important for successful work. The school work with computers must be organized in a way that ensures activity, individualization and differentiation for all pupils. Some diversity in the material complexity is favorable: some easier topics for the 3rd grade can be used by pupils in lower classes and opposite, more complex topics are appropriate also for higher classes. It is important to note that the use of e-learning materials (at home) does not introduce discrimination: pupils from weaker social environments (which possibly cannot afford computers and internet) are not deprived in comparison to others since usual textbooks and school work with computers can complement the home work. They have opportunity to access the e-learning materials at school after regular classes.

We built the e-learning materials for the subject Environmental Education for 3rd grade because there were almost no similar materials before. Only the teachers are qualified enough to evaluate the pupils' success in the school. They verify different educational methods and provide us valuable feedback. Therefore we developed e-learning materials in different phases:

1) the development of materials;
2) teachers' verification and validation of the materials;
3) revision/upgrade of materials.

6. Acknowledgements

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