IT EDUCATION – CHALLENGING THE LIMITATIONS INSTEAD OF LIMITING THE CHALLENGES

Evgenia Sendova
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences
Sofia, Bulgaria

Eliza Stefanova
FMI
St Kliment Ohridski University of Sofia
Sofia, Bulgaria

Pavel Boytchev
FMI
St Kliment Ohridski University of Sofia
Sofia, Bulgaria

Nikolina Nikolova
FMI
St Kliment Ohridski University of Sofia
Sofia, Bulgaria

Eugenia Kovatcheva
FMI
St Kliment Ohridski University of Sofia
Sofia, Bulgaria

The computer is but a means, a tool and a useful instrument and remains one as long as people manage to use it well.

John Atanasoff

ABSTRACT

The paper deals with addressing the most typical limitations and challenges the ICT teachers in Bulgaria (and all over the world) are confronted with. A set of ICT textbooks and supporting instrumentarium for 5th, 6th and 7th grades are considered. The specifics of these educational materials is that they allow both the students and their teachers to express themselves in various fields while covering the Standards' requirements for building ICT skills for the corresponding age. The advantages of the project-based learning are discussed and the new role of the teachers when applying active learning methods is emphasized on.

I. INTRODUCTION

Policy makers pay attention to informatics education, hoping that a young population well-educated in this modern technology will contribute to the future wealth of the nation. *But are such high aspirations justified? What should school aim at in order to live up to such expectations?* These and similar questions have been considered in almost every country implementing Information and Communication Technologies (ICT) in the school curriculum either as a separate subject (as it is the case in Bulgaria), or integrated in the rest of the school disciplines.

In most of the cases teaching ICT is determined by the rules and the standards of the Ministry of Education. But this is hardly the main limitation since the traditional way of introducing ICT as a subject has been focused on studying the tools rather than using them as means of expressing oneself in a specific field (be it the teacher or the student).

These problems have been addressed in the frames of Leonardo da Vinci *I*Teach* project [1], in which the notion of *ICT-enhanced skills* has been defined as a synergy between the technical and the *soft* skills required by the Life Long Learning society. Four groups of such skills have been identified by the project partners as being of crucial importance, viz. working in a team, working on a project, information skills and presentation skills. The *I*Teach* methodology is based on active learning methods - the student is in the center of the learning process, the teacher is a guide and a partner in a project work based on didactic scenarios encouraging the creative thinking of students [2].

But the methodology itself couldn't be implemented without appropriate textbooks tuned to the interests of the students and to the expertise of the teachers. With this in mind, a set of ICT textbooks and supporting instrumentarium (in terms of software and evaluation tools) for 5th, 6th and 7th grades have been developed (the authors of this paper being part of the developers' team) which not only cover the requirements for building ICT skills for that age but allow both the students and their teachers to express themselves in various fields (mathematics, poetry, graphic design, fine arts). These materials are an attempt to address the question of how to break the educational traditions by challenging the limitations and providing stimulating challenges for the students.

Let us first throw a glance at the most typical limitations the ICT teachers in Bulgaria (and not only) are confronted with.

II. SOME TYPICAL LIMITATIONS AND CHALLENGES

The first serious problem ICT teachers are facing is the conflict between the expectation of the society and those of the educational policy makers: on one hand the society expects from the future citizens interdisciplinary and soft skills needed for achieving a variety of real-life goals; on the other teachers have to follow a strict curriculum according to the educational standards (acquiring technical skills mainly) in a relatively limited time and in a fixed order.

Another important problem is the variety of preliminary ICT knowledge among the students in the junior-high school. This leads both to the lack of motivation for those who have already acquired the expected technical skills prior to the introduction of IT at school, and to a feeling of intimidation for the rest.

Furthermore, while the emphasis of the teaching is put on the technology itself it is normal that teachers *converted* to be IT teachers from other subjects (mathematics, arts, natural science, etc) and *not swimming in their own waters* should feel uncomfortable to make their teaching process learner-centered. They would rather teach in the good old *preaching* style thus demotivating additionally the students.

Within these conditions, when offered to use active learning methods to overcome this demotivation the teachers would usually refer to the lack of

- appropriate materials in the spirit of the constructivist teaching and learning
- relevant evaluation mechanisms, and
- sufficient time

III. CHALLENGING THE LIMITATIONS

Next we will try to explain the specific of our approach in the above mentioned textbooks (Figure 1) and of the supporting instrumentarium that would hopefully help the teachers challenge these limitations.

Figure 1: The textbooks.

The first idea of course has been to cover the requirements imposed by the standards in contexts meaningful both for the students and for the knowledge/creativity based society. As Chickering and Gamson suggests [3], in order to be actively involved students should not only listen but also read, write, discuss, or be engaged in solving problems. Most important, they should be engaged in such higher-order thinking tasks as analysis, synthesis, and evaluation. Using active learning techniques in the classroom is found vital because of their powerful impact upon students' learning. Our approach is based on numerous studies having shown that strategies promoting active learning are superior to lectures in promoting the development of students' skills in thinking and writing.

Here are some of the main features of our set of ICT textbooks:

- **The Structure** is clear with well defined sections:
  - **A short introduction** in which the main objectives, both technical and soft skills to be acquired, are specified;
  - **The new notions** in Bulgarian and English language;
  - **The challenge** - a creative task motivating the introduction of new knowledge and skills, stimulating students to find and describe different ways to the final goal and encouraging the spirit of cooperativeness (Figure 2);

Figure 2. The challenge: *how to preserve the national inheritance by means of ICT*

  - **Creative tasks** spread in several subsections, e.g. *Roll up your sleeves*, *Give free rein to your imagination*, etc
  - **Amusing stories**

Typical for the structure of textbooks is that there is a common *thread* linking

– the tasks in a lesson (5th grade [4]),
– the lessons in a common ICT theme (6th grade [5]),
– the ICT themes in the whole textbook (7th grade [6])

in specially designed didactic scenarios.

- **The language** is tuned to the age specifics. A special attention is paid to the lessons' titles which are short, understandable and intriguing (unlike the tedious and too technical titles from the standards). Compare our title *How to format a text as a long and a sad mouse tail* with: *Formatting the text at a paragraph level. Setting up the properties of the pages in a text document. Numbering of the pages.* Let us note that each lesson title is in the form of a question whose answer is to be revealed by the students in the learning process. Furthermore, the titles of the textbooks themselves are oriented to the young readers putting them in the role of creative partners of the authors and the teachers: *The computer in my world*, *I am learning and creating with a computer*, *You and IT*.
- **The paths to solving the challenge** are various. To prepare the students for citizens of the knowledge/creativity based society we try to encourage them to discover various solutions to the problem and compare them according to specific criteria (rather than to apply recipes in the style *click and drag*). For instance, after two descriptions of how to open a file an empty column is added (Figure 3) to be filled by the students with some other ways they have discovered. It is their very description that helps the students make sense of the specific skill.

Мога да го направя така:	Или пък така:	Открих и друг начин!
Стартирам програмата **Paint**. От менюто **Файл** избирам **Отвори...** Отивам на диска, отварям папка **Graphics** и отварям файл **2_kubcheta.**	Стартирам програмата Paint. Отивам на диска, отварям папка Graphics. Щраквам върху файла 2_kubcheta и го тегля до програмата Paint.	1. .... 2. ....

Figure 3. Describing various ways of opening a graphic file to be edited

- **The spirit** is friendly and collaborative.

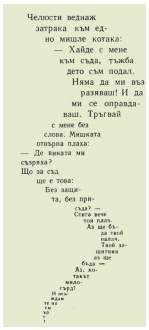
Although all the textbooks share the same features there is specifics in each one of them related to the age of the students, of course. For instance, the interactivity is achieved in 5th grade by introducing two sympathetic characters (a boy and a girl with whom the learners might identify themselves) who are ready to ask about things they don't know or understand and to learn together with the students.

In the textbook for the next grade there is a stronger emphasis on the ICT-enhanced skills interweaved in projects of interest to the students and at the same time being more serious and challenging. In addition, the required ICT skills are achieved in the context of interdisciplinary scenarios which could be easily tuned to the expertise of the teachers - mathematics, history, mythology, art, etc. Here are some examples.

IV. ILLUSTRATIVE EXAMPLES

Visual poetry and acrostics

The notion of *text formatting* required by the ICT Standards is integrated in our textbooks in the context of emphasizing the content of a poetic work through its form. For instance, the tale of the mouse (from Lous Carroll's *Alice in the Wonderland*) is presented in the form of a mouse tail and Alice is described through an acrostic in Bulgarian (Figure 4). The students are encouraged to create their own variations (interpretations) of these examples.



Направи *характеристика в стил акростих* на Алиса:

- АКТИВНА
- ЛАСКАВА
- ИГРИВА
- СЪЗНАТЕЛНА
- АРТИСТИЧНА

Украси с някоя картинка, както е представена в оригиналното издание или в анимационния филм на Уолт Дизни:

Figure 4: Formatting in harmony with the content

The rabbits, necklaces and Fibonacci

This scenario introduces deep mathematical ideas (the Fibonacci numbers) in a real-life context both simple and interesting for the students (Figure 5).

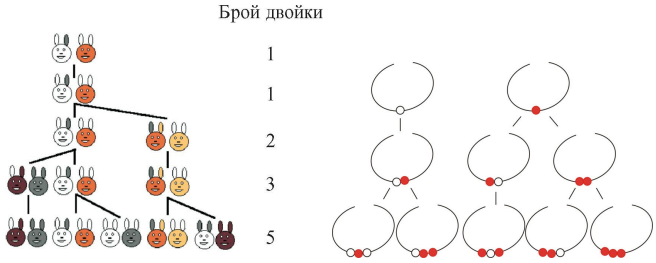


Figure 5: Fibonacci numbers in the context of grandpa's rabbits and grandma's necklaces

Here the emphasis is not on the introduction of new technical skills (formatting of cells in electronic spreadsheets) but on provoking students' imagination, mathematical thinking and raising their awareness of the relations between abstract mathematical notions, the nature and the fine arts.

Tessellations after Escher

The idea of bringing together knowledge from various fields is further intensified in the *Integration of activities* theme (6th grade). A typical example is the introduction of specific tools of a Graphic Editor (for copying and rotating) in the context of tessellating the plane with rather complex tiles in the style of Escher (Figure 6).

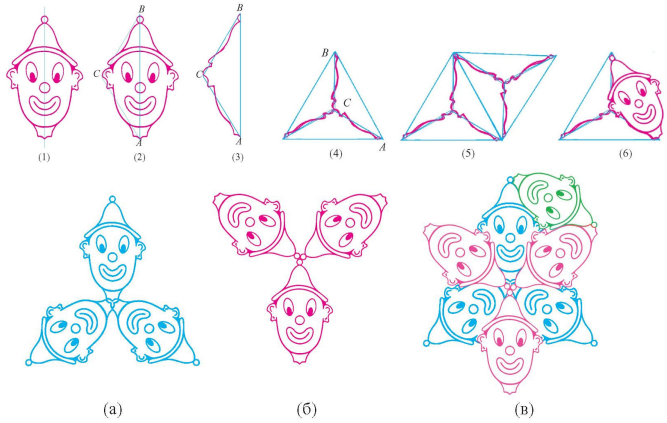


Figure 6: Tessellating the plane with the face of a clown

The students realise how their mathematical knowledge about symmetry and rotation could be harnessed in art and how it could be enhanced by the ICT tools.

Apart from the standard educational software provided in the Bulgarian schools specially designed computer applications based on *Elica* [7] have been integrated with the ICT activities in 6th and 7th grade. (On additional note these computer applications have been developed in Bulgaria in the frames of the DALEST project [8] for enhancing the spatial imagination of students [9] and have been successfully implemented in the mathematics education also in Cyprus, Greece, Portugal and UK.)

Students' motivation is enhanced by the Virtual Reality (VR) in each Elica application since they are used to VR in video games and movies. Further on, the problem of having students with different levels of ICT knowledge is addressed by making the applications easy to work with. Three-dimensional objects can be manipulated with mouse in an intuitive way leaving the students focused on the main problem.

As for time limitation of the classes, the Elica application can be downloaded from its web site and installed at a home computer for free. Thus students may continue with their explorations after school.

Last but not least, the applications are designed also to help teachers, especially those who are afraid that they know less than their students as far as the technical skills are concerned.

The goal of textbooks and the software is not just to help students learn, but also to help teachers teach and express their knowledge and abilities in the best possible way, viz. in the field of their original expertise. For example, there are projects in 6th and 7th grade in which students combine their artistic skills with their mathematical knowledge by means of various Elica applications. Products of these activities are illustrated in Figure 7 (a poster on mathematics and toys for a Christmas tree in the form of polyhedra).

Figure 7: Integrating mathematics and arts by means of *Elica*

The greatest accomplishment of our ideas is the final book of the series developed as a challenge itself with the theme of coding passing as a *red thread* through the whole content. Even its title **ТИ И ИТ** is a pun in Bulgarian since the first word (*you*) is the mirror image of the last one (IT) - a way of coding a message. Each lesson deals with ideas and tools for solving problems considered as milestones towards a final goal. For instance additional information about the properties of a table is introduced in the context of decoding messages using the so called *prisoner's code* (see also the coversheet of the textbook in Figure 1). Cesar's code is introduced as a context for implementing new information about spreadsheets and artistic arrangements of text (Figure 8).

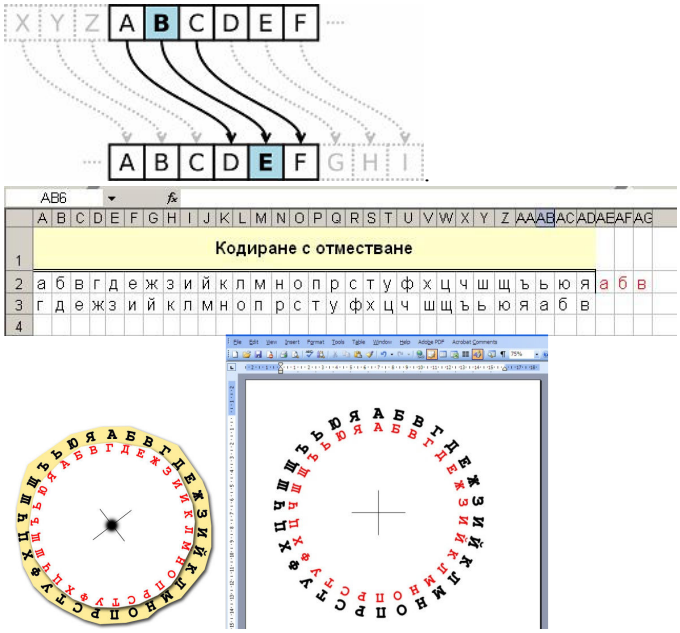


Figure 8: Possible presentations of Cesar's code

Thus each lesson in the textbook for 7th grade provides implicitly ideas and means for solving the puzzles offered by the authors at the end.

The *grand finale* is a project requiring the students to put together all the subject knowledge and skills acquired during the school year and to work creatively in teams for the achievement of a common goal. During the project the students are faced with problems from real life and are expected to understand in a natural way *when*, *how* and *which* ICT tools to apply so as to solve the challenge of restoring archeological artifacts (Figure 9).

Figure 9: The challenge of restoring ancient vessels

For the purpose students are encouraged to explore computer models (Figure 10) and to decode a message (Figure 11) with hieroglyphs so as to help a local museum to restore ancient Greek vessels and guess their function.

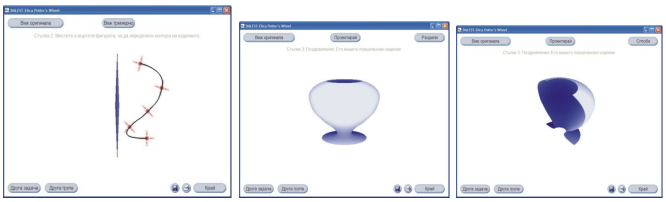


Figure 10: The computer model developed on the basis of an *Elica* application

Figure 11: The coded message

The project is a stand-alone entity in which students are expected to demonstrate their problem solving skills by means of ICT.

The project is designed as a prototype of a real large-scale project. The tasks in the project are connected at various levels of abstraction. Some tasks can be done in parallel, others require sequential execution. All these details are something which the students must realize as a first step of the project. They are also expected to split in teams and distribute work forces according to their skills and the amount of work.

The resemblance to a real project goes to the level of having teams perform their tasks by designing their approach, then implementing it and finally, preparing a deliverable (or a report) which is evaluated by the teacher. The deliverables could also be input data for other teams' tasks.

The project ends with a report in which the team presents its work in front of the class.

The idea of incorporating project activities into the classroom has goals going far beyond the typical summary. By taking part in the project students learn by experience about the specifics of the team work, the importance of deadlines, preparing and presenting results, relying on somebody else's work as well as having other rely on their own work, and coping with a dynamic collaborative environment.

The preparation and presentation of the final reports are a very important part of the project as well. The students gain a valuable experience in demonstrating their work - they learn how to stand out their ideas, how to tune the presentation to a specific audience. Skills acquired through this activity are certainly not narrowed to just IT and could be applied further on in various aspects of students' life.

V. CONCLUSIONS – THE NEW ROLE OF THE TEACHERS

As Bertrand Russel has stated *the methods and the spirit of teaching are more important than the curriculum.* The role of the teacher when applying methods for active learning as suggested in our set of ICT textbooks involves a lot of courage, dedication and readiness to be a life-long learner. In the project-based learning the teachers become natural partners of their students in planning, task distribution among the team members, information search, modeling and presenting – a process very close to what the genuine scientific research is. Such a role (as challenging as it is) could be very rewarding and all the teachers we had the chance to work with during several training courses and workshops proved to be ready for it. Inspired by the new possibilities they were able to overcome their fears since they realized that the proposed activities emphasized on thinking and exploring rather than on advanced technical skills.

With education based on such principles we believe that students will become *proud members of the Life Long Learning society* – able to cope with the dynamics of the ICT technology and various innovations in their future life. Our inspiration has been the Chinese proverb *Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime*.

REFERENCES

[1] Innovative Teacher project site http://i-teach.gmi.uni-sofia.bg

[2] Sendova E., Stefanova E., v. Deepen N., Forcheri P., Dodero G., Miranowicz M., Brut M., et al Innovative Teacher - Methodological Handbook on ICT-enhanced skills, Faleza-Office 2000, Sofia, 2007

[3] Chickering, A.W. & Gamson, Z.F. (1987), *Seven principles for good practice in undergraduate education*. AAHE Bulletin, 39(7), pp. 3-7.

[4] Dobreva M., Kovatcheva E., Nikolova N., Sendova E., Stefanova E., The computer in my world (Компютърът в моя свят – учебно помагало по информационни технологии – 5 клас, Анубис, София, 2006)

[5] Dobreva M., Kovatcheva E., Nikolova N., Sendova E., Stefanova E., *I learn and create with a computer* (Уча и творя с компютър – учебно помагало по информационни технологии – 6 клас, Анубис, София, 2007)

[6] Sendova E., Stefanova E., Kovatcheva E., Nikolova N., Boytchev P., You and the ICT (Ти и ИТ учебно помагало по информационни технологии – 7 клас, Анубис, София, 2008)

[7] Elica site http://www.elica.net

[8] DALEST project site http://www.ucy.ac.cy/dalest/

[9] Boytchev, P ., T . Chehlarova, E . Sendova. *E nhancing spatial imagination of young students by activities in 3d Elica applications* . Proc . of the 36th Spring Conference of the Union of Bulgarian Mathematicians, 2007, Varna , Bulgaria , pp. 109-119

[10] Dobreva M., Kovatcheva E., Nikolova N., Sendova E., Stefanova E., A Book for the ICT teachers for 5th grade (Книга за учителя към учебно помагало по информационни технологии за 5 клас "Компютърът в моя свят", Анубис, София, 2006)

[11] Sendova E., Stefanova E., Kovatcheva E., Nikolova N., Boytchev P., A Book for the ICT teachers for 6th grade (Книга за учителя към учебно помагало по информационни технологии за 6 клас „Уча и творя с компютър", Анубис, София, 2007)